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ONE-DIMENSIONAL MODELING OF BROMIDE TRACER AND TRICHLOROETHYLENE TRANSPORT BASED ON LABORATORY EXPERIMENTS IN VERTICAL SOIL COLUMNS

by

Keri L. Murch

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Geology

UTAH STATE UNIVERSITY
Logan, Utah

2003

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ABSTRACT

One-Dimensional Modeling of Bromide Tracer and

Trichloroethylene Transport Based on Laboratory

Experiments in Vertical Soil Columns

by

Keri L. Murch, Master of Science

Utah State University, 2003

Major Professor: Dr. Tom Lachmar
Department: Geology

Enhanced biodegradation using carbon donor and microbial addition is being considered as a possible remediation technique for a trichloroethylene (TCE) contaminated area in Sunset, Utah, west of the source area on Hill Air Force Base. As a precursor to any in situ remediation attempts, several laboratory treatability experiments are being conducted, including the construction of microcosms and flow-through columns. Nine large-scale flow-through columns were built using site groundwater and aquifer material. Bromide tracer tests were conducted to establish and understand the hydraulic conditions within the columns prior to the commencement of the TCE biodegradation experiments. Four predictive models were created to show potential degradation scenarios in the columns and in the field using microcosm data for various system treatments. Treatments selected for modeling indicated that carbon addition alone is insufficient in stimulating dechlorination of TCE. Microbial amendments will be necessary in the column systems when the TCE dechlorination experiments begin.

(331 pages)

ACKNOWLEDGMENTS

I would like to thank Dr. Tom Lachmar for convincing me to come to Utah State and for serving as my major professor. I would especially like to thank Dr. Ryan Dupont for giving me the chance to work on the Hill Air Force Base project, providing guidance and support during my research, and for serving on my committee. I would also like to thank Dr. Bill Doucette for his support during my research and for serving on my committee. I would like to give special thanks to Dr. Michael Sukop for his guidance and support during the first bromide tracer test and initial use of CXTFIT.

I would like to thank Alan Taylor and the UWRL Hydraulic Laboratory staff for their help and coordination in the soil mixing adventure. I would also like to thank Hosam Jamal for all his help with the bromide sampling and analysis.

I would like to thank my family and friends at home for their undying love, support, and confidence in me during these two years at USU. I would like to thank all of my friends here in Logan for reminding me that there's always time for a drink and good conversation.

Keri L. Murch

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CHAPTER 1

INTRODUCTION

Biodegradation is a natural process by which indigenous microorganisms metabolize organic contaminants in soil and groundwater. In order to maintain and promote this biodegradation, attempts are made to modify conditions in the subsurface to enhance the microorganisms' behavior. Several methods of enhancement are useful, including the addition of an electron acceptor such as oxygen, nutrients such as nitrogen and phosphorous, and energy sources such as carbon.

Enhanced biodegradation using carbon donor and microbial addition is being considered as a possible remediation technique for a contaminated area in Sunset, Utah. The contamination originates from Hill Air Force Base, east of Sunset, and consists primarily of a chlorinated solvent called trichloroethylene (TCE). Figure 1-1 shows the location of Sunset and Hill Air Force Base, relative to Logan and Salt Lake City.

TCE is a colorless, nonflammable liquid that has a sweet odor and a sweet, burning taste. Vapor degreasing of metal parts in machinery accounts for 80 percent of TCE's use (US EPA 2002). TCE has been found at 246 of the 1035 Environmental Protection Agency's Superfund sites.

As a precursor to any in situ remediation attempts, several laboratory treatability experiments are being conducted. One of these is the construction of nine 6-inch (15.24 cm) diameter flow-through columns. Along the 6-foot (182.88 cm) length of the columns are five sampling ports used for collection of water samples during the experiments. Prior to commencing carbon addition and TCE degradation experiments, bromide tracer

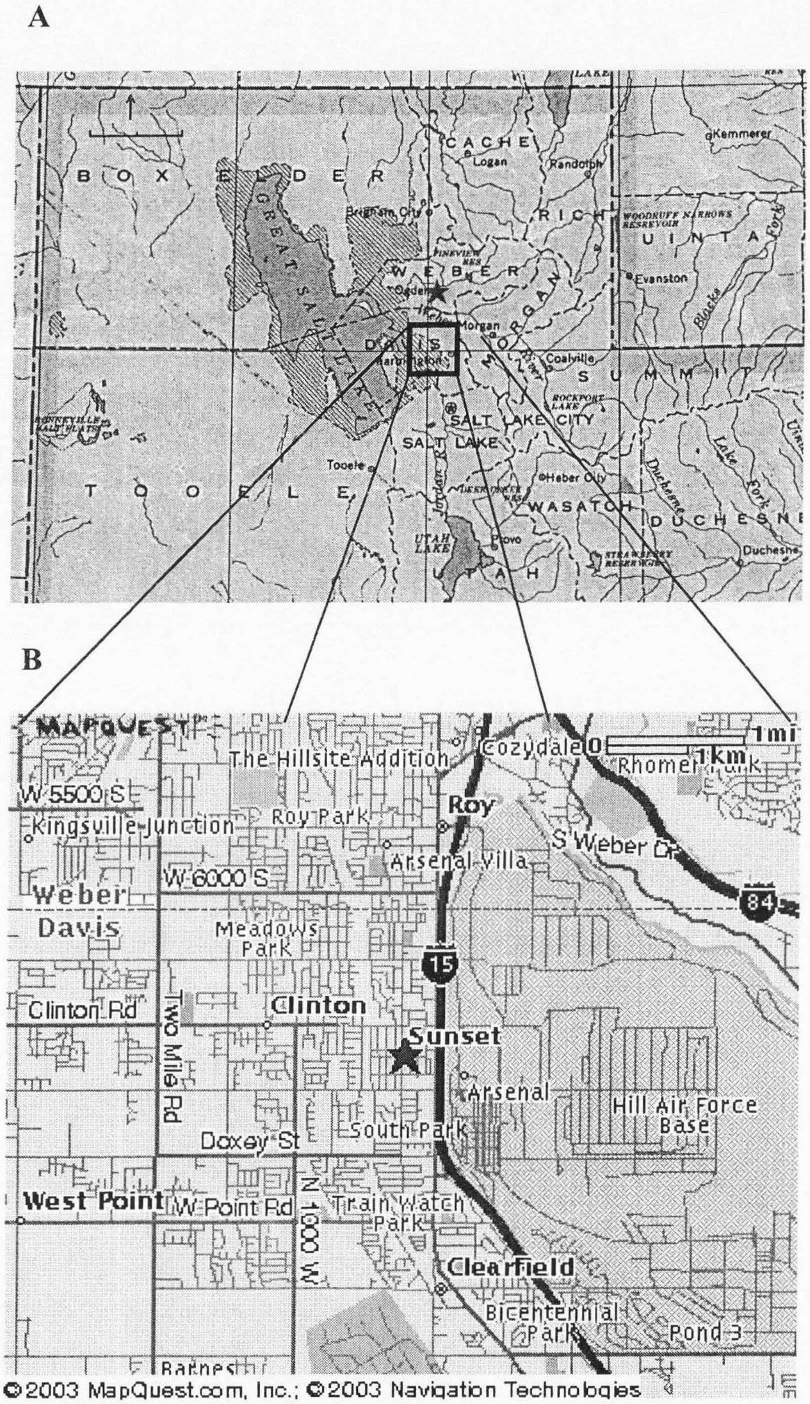


Figure 1-1. A) Map of northern Utah showing location of Sunset area, B) map of Sunset and Hill Air Force Base.

tests were conducted on the columns. The purpose of conducting these tracer tests before the degradation experiments was to determine preliminary hydraulic conditions in the columns. An additional bromide tracer test was conducted approximately 6 months after the first bromide tracer test. This latter bromide tracer test was used to examine the changes in hydraulic conditions during the time elapsed between tests.

The overall question driving this study is whether the addition of carbon donors and microbial innocula to the groundwater and soil system simulated in the columns is effective in stimulating the reductive dechlorination (degradation) of TCE. System simulations were created in the form of microcosms to study the effectiveness of various carbon donors and microbial populations before they are applied to the large-scale column systems. Treatments for the microcosm study were constructed using site soil, nutrient solution, carbon donor (whey, lactic acid, coconut oil, high melting point oil, low melting point oil, hydrogen releasing compound [HRC], or an emulsified oil), and TCE amended groundwater with a 1:10 dilution of two microbial cultures (MBI Granular or Bachman Road). Evaluations were made of the effectiveness of the carbon donors and microbial communities in enhancing the dechlorination of TCE by examining the changes in concentrations of TCE and its daughter products over a 10-week sampling period. Using the data obtained from four selected treatments during these microcosm experiments, first-order degradation rates were estimated and used to create predictive models for the column systems. These predictive models serve to show the potential effectiveness of the carbon donor and the microbial culture amendment treatments and the spatial distribution of dechlorination reactions occurring in the columns.

Objectives

The overall objectives of this study were to: 1) build and prepare the nine flow-through columns for the bromide tracer tests and carbon-enhanced TCE biodegradation experiments, 2) use information provided by the tracer data breakthrough curves (BTCs) to understand and quantify hydraulic conditions in the column systems, and 3) to provide potential degradation scenarios in the columns and in the field using microcosm data for various system treatments.

In order to meet these project objectives, the following specific tasks were completed:

1) Columns were built and prepared for bromide tracer test and carbon-enhanced TCE biodegradation experiments. They were prepared by:
   a. Packing each column to a bulk density of 1.6 kg/m^3 and saturating it by pumping de-ionized water through from bottom to top.
   b. Pumping site groundwater through at a rate estimated to simulate site conditions.
2) Three tracer studies were conducted using bromide as a non-reactive tracer. The first and second were run upon completion of construction of the soil columns. The last took place 6 months later to evaluate hydrologic changes within the columns over time.
3) The BTCs generated from these tracer tests using concentration versus time data were analyzed individually to:
   a. Evaluate flow patterns and tracer retention times within the columns.

b. Ensure hydraulic conditions were acceptable for conducting the carbon-enhanced dechlorination experiments.

c. Determine if significant changes in hydraulic conditions and amount of dead space had occurred during the six-month period between tests.

4) A series of representative microcosm data illustrating the effectiveness of the carbon donor and microbial populations in various treatments were selected for use in column study modeling.

5) Using the selected microcosm TCE data, including intermediate products produced during dechlorination, the transport and transformation of these constituents were analyzed and modeled using a one-dimensional flow and transport model. The model was used to:

   a. Create predictive models for the column systems under each of the selected microcosm treatments.

   b. Examine the effect of the carbon donor on the transport and reductive dechlorination of TCE and its daughter products cis-dichloroethylene (cis-DCE), and vinyl chloride (VC).

   c. Examine the differences in dechlorination effectiveness of TCE, cis-DCE, and VC between the two microbial populations.

   d. Provide possible reasons for the differences among the selected treatments.

Personal Statement

Constructing the columns, running the bromide tracer tests, learning to model the tracer tests, and learning to model the TCE dechlorination are the most difficult activities I have ever had to complete in my geology career. However, they have been the most rewarding in terms of information learned and experience gained. In my original proposal, I was going to be modeling the actual dechlorination of TCE in the flow-through column system. Unfortunately, scheduling conflicts prevented me from completing this portion of the study. The predictive modeling of TCE dechlorination included in this paper is in place of the actual modeling of data collected during the treatability experiments.

CHAPTER 2

LITERATURE REVIEW

Soil Columns

Soil Preparation

Soil columns are commonly used to simulate aquifer profiles or soil horizons in laboratory studies. Columns are built using undisturbed soil cores (Zurmühl 1998, Perret et al. 2000, Kamra et al. 2001) or disturbed soil samples. When using disturbed soil samples, it is often necessary to homogenize the soil by drying, crushing, and sieving, among other techniques (DeBruin et al. 1992, Li et al. 1993, Krzyszowska et al. 1994, Veeh et al. 1994, Quanrud et al. 1996, Nuñez-Delgado et al. 1997, Smith et al. 1997, Hunkeler et al. 1998, Periago et al. 2000).

Packing Techniques

After soil has been homogenized, it is ready to be packed into the columns of choice. DeBruin et al. (1992), Powelson and Gerba (1994), and Hunkeler et al. (1998) packed their columns using wet soil. The other option is to pack the columns with dry soil and saturate them following packing (Li et al. 1993, Krzyszowska et al. 1994, Veeh et al., 1994, Davis and Olsen 1995, Quanrud et al. 1996, Nuñez-Delgado et al. 1997, Smith et al. 1997, Periago et al. 2000). The dry soil is packed in thin layers (Li et al. 1993, Krzyszowska et al. 1994, Powelson and Gerba 1994, Davis and Olsen 1995, Nuñez-Delgado et al. 1997, Periago et al. 2000) to avoid stratification. The newest soil layer is then compacted with a tamping device to avoid uneven settling and to achieve a uniform bulk density in the column (Li et al. 1993, Krzyszowska et al. 1994, Davis and Olsen 1995).

Saturation

In order to create a true saturated soil column, all pores should be filled with water. Saturation from the bottom of the soil column to the top serves to push out the air trapped in pore spaces between grains and replace it with water. Several authors saturated their columns from bottom to top for this reason (Krzyszowska et al. 1994, Nuñez-Delgado et al. 1997, Smith et al. 1997, Culver et al. 2000, Periago et al. 2000, Kao et al. 2001). Li et al. (1993) saturated their column from the top through a ceramic plate and Mihopoulos et al. (2000) used an unsaturated soil column for their study.

Column Size

Of the studies reviewed for this paper, three categories of column size were identified. Small columns were those measuring 1 to 30 centimeters in length, medium 31 to 59 centimeters, and large were longer than 60 centimeters. Diameters of the columns varied from 1 to 10 centimeters, with one much larger at 20 centimeters, and the majority under 5 centimeters wide. Studies using small columns include those by De Bruin et al. (1992), Veeh et al. (1994), Davis and Olsen (1995), Kelly et al. (1996), Smith et al. (1997), Zurmühl (1998), Chendorain and Ghodrati (1999), Harmon et al. (1999), Culver et al. (2000), Perret et al. (2000), Kamra et al. (2001), Kao et al. (2001). Krzyszowska et al. (1994), Hess et al. (1996), Nuñez-Delgado et al. (1997), and Hunkeler et al. (1998) used medium sized soil columns for their research. Large-scale soil columns were built and used by Wilson and Wilson (1985), Li et al. (1993), Powelson and Gerba

(1994), Quanrud et al. (1996), and Periago et al. (2000). Columns on the order of 3 meters in length and 15 centimeters in diameter like those being used in this study were not found in the literature.

Tracer Tests

Purpose of Tracer Tests

Tracers are used in both laboratory and field studies to help define and illustrate hydraulic parameters. Water velocity and direction can be directly determined while several other parameters can be inferred or calculated using information obtained from the tracer test. These parameters include hydraulic conductivity, porosity, flux, hydrodynamic dispersion, dispersivity, and retardation (Wilson and Mackay 1993). Tracer tests can also help determine changes in soil structure over time, such as the development of channeling or macropores. Determining the presence of macropores is critical because it has been shown by Germann and Beven (1981) that even a small amount of macroporosity can increase the flux of a saturated soil by more than one order of magnitude (Beven and Germann 1982).

Tracer Types

According to Davis et al. (1980), an ideal tracer is nontoxic, inexpensive, moves with the water, does not alter the water direction or velocity, is chemically stable, has low natural system background concentrations, is easily measured in trace amounts, and is not sorbed by the surrounding medium. Davis et al. (1980) conducted a review of available groundwater tracers and determined that ionized substances, stable isotopes, radioactive substances, organic dyes, gases, fluorocarbons, and solid particles are all useful as tracers in certain environments. However, there are some drawbacks associated with some of these tracers. Radioactive substances are toxic to the environment and oftentimes to those personnel handling them, some organic dyes sorb easily onto solid materials, some gases require very expensive analysis, and solid particles can become trapped in the soil or rock as they flow along with the water. The most widely used tracers are ionic salts containing bromide or chloride (Wilson and Mackay 1993). Bromide is generally preferred over chloride because it tends to have very low natural system background concentrations in soil and groundwater. Sodium bromide (NaBr) and potassium bromide (KBr) are two compounds that are commonly used as a source of bromide ions in both laboratory and field studies (Davis et al. 1980, Bowman 1984, Fedler et al. 1989, Roberts et al. 1990, Li et al. 1993, Krzyszowska et al. 1994, Smith et al. 1997, Hunkeler et al. 1998). Other tracers that have been proven useful include iodide, thiocyanate, m-trifluoromethylbenzoic acid, pentafluorobenzoic acid, o-trifluoromethylbenzoic acid, 2,6-difluorobenzoic acid (all reviewed by Bowman 1984), and sulfur hexafluoride (SF_6) (Wilson and Mackay 1993).

Concentration Requirements

Although bromide can be detected at levels as low as 0.5 mg/L, the tracer should be applied at a concentration at least two orders of magnitude higher than the lowest detection level (Wilson and Mackay 1993). However, excessively high concentrations of ionic salts can have negative effects on the soil system (Wilson and Mackay 1993). One effect of introducing high concentrations of ions into a soil system is the potential for increasing the solubility of some minerals by decreasing activity coefficients with the increased ionic strength. The dissolution of minerals in the soil can lead to changes in the porosity of the sediment and therefore inaccurate hydraulic parameter data (Wilson and Mackay 1993).

Tracer Application

Tracer tests can be conducted using either a continuous application or a pulse of the desired tracer substance. With the continuous application method, tracer breakthrough is considered to be the time at which the tracer concentration at the sampling location is constant and equal to the applied tracer concentration. With a pulse application, the tracer breakthrough is the time at which the highest concentration of the moving pulse passes the sampling location. Both types of tracer applications yield breakthrough curves that can be used to determine the desired hydraulic parameters. A continuous application can be used (Willson et al. 2000), or a pulse can be used to create the breakthrough curves (BTCs) (Davis et al. 1980, Beven and Germann 1982, Bowman 1984, Fedler et al. 1989, Roberts et al. 1990, Li et al. 1993, Wilson and Mackay 1993, Krzyszowska et al. 1994, Smith et al. 1997, Hunkeler et al. 1998, Kamra et al. 2001).

Modeling Tracer Tests

One of the most common computer programs found in the literature to be used for modeling tracer tests is CXTFIT. CXTFIT is a one-dimensional solute transport model that uses a non-linear least-squares fit of the BTCs produced by tracer tests in homogenous systems (Veeh et al. 1994). The original code was written by Parker and van Genuchten in 1984. Toride, Leij, and van Genuchten modified and updated the code to Version 2.1 in 1995. CXTFIT uses the convection-dispersion equation to approximate solute transport parameters from observed concentrations (inverse problem) and predicts solute concentrations (direct problem) with given transport parameters (Toride et al. 1995). Veeh et al. (1994), Hunkeler et al. (1998), and Periago et al. (2000) each used CXTFIT to estimate transport parameters and to model the tracers used in their studies.

Veeh et al. (1994) compared CXTFIT models with the LEACHMP model from Wagenet and Hutson (1986). LEACHMP consists of various models that approximate water flow, solute transport, solute degradation, water uptake by plants, and potential evapotranspiration (Wagenet and Hutson 1986). It is geared towards studies taking place in the unsaturated soil zone.

HYDRUS-2D is another model that can be applied to tracer test analysis. HYDRUS-2D is a numerical modeling program that has the ability to simulate one- and two-dimensional saturated fluid flow, heat, and solute transport (Diodato 2000). This program is relatively flexible, allowing for heterogeneous systems, irregularly shaped model domains, and zero- and first-order solute degradation (Diodato 2000). One major flaw Diodato found in his review of the program was that it tended to produce plots that had credible appearances even when there was substantial dispersion in the solution.

Enhanced Biodegradation

Enhanced biodegradation refers to the addition of a substance to the contaminated zone to stimulate the microorganisms' ability to process a contaminant. Depending on the type of contaminant, there are several methods for enhancing biodegradation in the subsurface. Studies have been conducted evaluating various ways of enhancing biodegradation.

Enhanced biodegradation methods were previously thought to be ineffective on chlorinated solvents such as TCE. Recent studies have proven otherwise, as others have had tremendous success in degrading TCE to harmless constituents.

Aerobic Degradation

Aerobic degradation of TCE involves the complete breakdown of the compound into CO_2 and water by using the chlorinated solvent directly as an electron donor. In general, the least chlorinated compounds in the degradation series, specifically cis-dichloroethylene (cis-DCE) and vinyl chloride (VC), are most susceptible to aerobic degradation by serving as a primary substrate (US EPA 1998). Natural attenuation of TCE and its daughter products (excluding VC) under aerobic conditions proceeds primarily by advection, dispersion, and sorption (US EPA 1998). However, VC can be oxidized under aerobic conditions (US EPA 1998). Studies have shown effective TCE degradation using various treatments in aerobic systems (Wilson and Wilson 1985, Little et al. 1988, Oldenhuis et al. 1989, Kao et al. 2001). Methane and oxygen can be added in aerobic systems to stimulate the production of methane monooxygenase, an extracellular enzyme that degrades TCE. An alternative option currently employed for the aerobic degradation of TCE, particularly in groundwater, is the use of phytoremediation. The United States Air Force has had success with eastern cottonwood trees that metabolize TCE and support the presence of microbes that serve to break down the TCE (Weed 2000).

Anaerobic Degradation

Anaerobic degradation of TCE is also commonly referred to as reductive dechlorination. Reductive dechlorination involves the removal of one chlorine atom at a time from the TCE molecule and replacement with a hydrogen atom. This process takes place three times until the molecule becomes non-toxic ethylene. Figure 2-1 is a diagram showing the common pathways of reductive dechlorination. Reducing conditions must exist in the subsurface system naturally or be induced by adding substances to the system. Hopkins et al. (1993) used poly β-hydroxybutyrate (PHB) to create a reducing environment. The limiting step in this series of dechlorination reactions is the removal of the last chlorine atom to transform vinyl chloride (VC) to ethylene (Freedman and Gossett 1989). This is a major concern because VC is more persistent under anaerobic conditions and 100 times more toxic than TCE.

Electron Donors

In order for reductive dechlorination to occur, two electrons are necessary to transfer the hydrogen atom onto the molecule in place of the chlorine atom. Substances used as electron donors are almost as varied as the studies on anaerobic degradation of TCE. Acetate, glucose, formate, methanol, lactate, propionate, crotonate, butyrate, ethanol, hydrogen, butyric acid, lactic acid, propionoic acid, benzoate, and Hydrogen Releasing Compound (HRC) are just a few of the numerous electron donors commonly used (Freedman and Gossett 1989, De Bruin et al. 1992, Hopkins et al. 1993, Smatlak et al. 1996, Ballapragada et al. 1997, Fennel et al. 1997, Ellis et al. 2000, Mihopoulos et al. 2000, Zahiraleslamzadeh and Bensch 2001). These compounds provide a carbon source

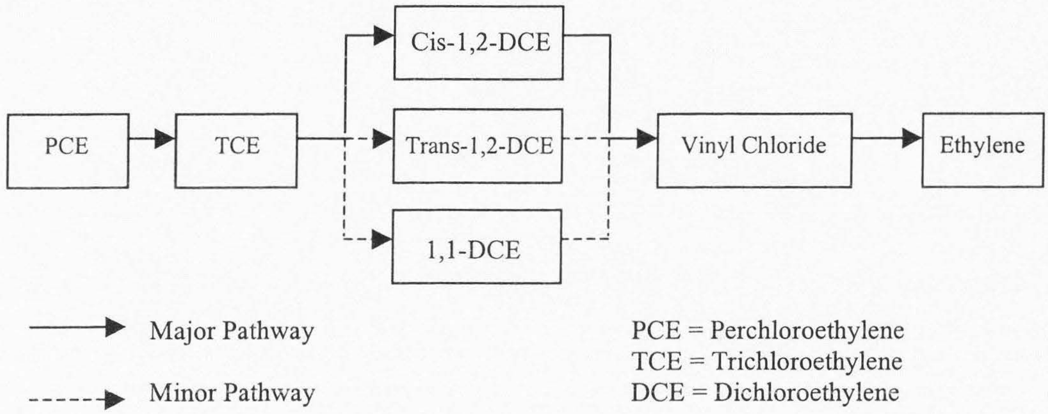


Figure 2-1. Dechlorination pathways for TCE. Modified from US EPA, 2000.

(energy source) for the microorganisms and enable the microbes to continue contributing to the chemical reactions that drive reductive dechlorination (US EPA 1998). Each of these studies resulted in reduced amounts of TCE in the soil systems. Also, the degradation rate tended to slow down considerably when the electron donor was not added to the system or had been depleted in the system (Freedman and Gossett 1989). In general, anaerobic reductive dechlorination is an electron donor-limited process (US EPA 1998). According to the EPA publication on natural attenuation of chlorinated solvents (US EPA 1998), there are two types of degradation behavior based on the type of carbon source available in the subsurface. Type 1 behavior is characterized by use of anthropogenic carbon, such as BTEX (benzene, toluene, ethyl benzene, and xylene) or landfill leachate, as the primary microbial substrate driving the dechlorination process (US EPA 1998). Naturally occurring carbon sources are used as the primary microbial substrate for dechlorination in Type 2 behavior (US EPA 1998).

Other Anaerobic Systems

In addition to supplying electron donors, some authors have used other successful methods for dechlorinating TCE. Burris et al. (1995) investigated the sorption behavior of chlorinated solvents in iron-rich systems. The mechanism for the reduction of TCE by iron is poorly understood and the sorption behavior discussed by Burris et al. (1995) was previously unresearched. Butler and Hayes (2001) investigated the rates and production of intermediate products of TCE transformation by iron sulfide.

Microbial Participation

It has been demonstrated in several studies that microbial participation plays a crucial role in reductive dechlorination of TCE. One commonly utilized microbial population for aerobic degradation is methanotrophic bacteria (Lee et al. 1998). These microbes contain monoxygenase and dioxygenase enzymes that contribute to the dechlorination of TCE. This is an aerobic cometabolic reaction. In anaerobic systems, microbes gain energy from the overall dechlorination process when sufficient carbon donor (electron donor) is available. It has been shown that microbial participation is necessary for reductive dechlorination of TCE by the absence of dechlorination in autoclaved microcosms (Kleopfer et al. 1985, Barrio-Lage et al. 1986). In the microcosm studies conducted at the Utah Water Research Laboratory as a precursor to the column studies, no measurable dechlorination of TCE occurred in the abiotic (autoclaved) microcosms.

Microbial Cultures Included in the Hill Air Force Base Study

Two microbial cultures capable of degrading TCE were used in the microcosm studies and will be used in the treatability studies in the flow-through column systems. The first culture has been named the Bachman Road culture, based on its development location in Oscoda, Michigan. This is a suspended culture made up of organisms isolated from a contaminated field site. The second culture has been referred to as the Michigan Biotechnology Institute (MBI) microbial culture. This culture, which grows as a granule, was grown up from waste from a brewery waste treatment plant that used an up-flow expanded bed reactor for treatment. The above details about the microbial cultures were obtained from conversations with Dr. R. Ryan Dupont and text in the microcosm final report (Utah Water Research Laboratory 2003).

Nutrients

According to Shannon (1995), one drawback of bioremediation is the requirement of adding nutrients to the subsurface contaminated system. Nutrients are necessary to enhance the behavior of the microbes responsible for the degradation of chlorinated solvents. Unfortunately, nutrients also tend to activate other bacterial populations that can act detrimentally in the dechlorination process (Shannon 1995). These unwanted populations compete with the contaminant-processing microbes for electron donors and energy sources. The competing populations can also consume the contaminant-processing microbes themselves, thus removing them from the system and effectively stopping any reductive dechlorination that was taking place (Bergeron 1997). According to Bergeron (1997), biodegradation is most effective when the nutrient solutions are supplied in pulses. This serves to reduce the numbers of competing populations while still supplying the desired microbes with the substances they require to degrade the contaminants.

TCE Reductive Dechlorination Modeling

In order to properly illustrate the reductive dechlorination of trichloroethylene along the length of the soil columns, a computer program capable of modeling first-order decay is necessary. Two such programs are CHAIN and BIOCHLOR.

CHAIN

CHAIN was developed by M.Th. van Genuchten of the U.S. Salinity Laboratory in Riverside, California. This is a one-dimensional model illustrating the convective-dispersive transport of four species involved in a consecutive first-order chain of the form $E_1 \rightarrow E_2 \rightarrow E_3 \rightarrow E_4$ (van Genuchten 1985). Trichloroethylene fits this requirement having a decay chain of TCE→DCE→VC→ethylene, as shown in Figure 2-1. Options included in CHAIN include first-type (concentration-type) or third-type (flux-type) boundary conditions. It is assumed that the soil system is homogeneous and that adsorbed concentrations can be related to solution concentrations by linear and reversible isotherms (van Genuchten 1985). CHAIN is available in both MS-DOS and Windows formats. The USDA-ARS George E. Brown, Jr. Salinity Lab in Riverside, California, currently distributes CHAIN as part of its STANMOD Windows interface group of programs.

BIOCHLOR

BIOCHLOR was developed by C. Aziz and C. Newell of Groundwater Services, Inc. in Houston, Texas. This program simulates one-, two-, or three-dimensional degradation by natural attenuation from both constant and decaying contaminant sources. This program is capable of illustrating advective-dispersive solute transport as well as sequential first-order decay. BIOCHLOR makes several assumptions, including simple groundwater flow conditions (laminar and constant flow), and a homogeneous soil system, and is limited to the modeling of sequential first-order reductive dechlorination of chlorinated ethanes and ethenes (US EPA 2000). BIOCHLOR is written in user-friendly Windows using Microsoft Excel. BIOCHLOR is freeware and is available for download on the U.S. Environmental Protection Agency's website.

CHAPTER 3

COLUMN CONSTRUCTION

Methods

Column Configuration

Each of the nine columns is constructed of four separate glass pieces consisting of two end caps and two 3-foot (91.44 cm) lengths of hollow glass pipe for a total length of 6 feet (182.8 cm), as shown in Figure 3-1. Each piece has a diameter of six inches (15.24 cm). Soil length was measured from its level at the top of the upper 3-foot column section to the base of the bottom end cap. Soil length variance among columns was a result of small differences in bottom end cap depths. These and other significant measurements of the columns can be found in Table 3-1. A metal clamp, insulated by a rubber ring, is tightened at the intersections between pieces to connect the glass. These joints serve as supporting points for the weight of the column. The edge of the metal clamp rests on the horizontal wood pieces on the support structure. The bottom end cap and both three-foot lengths of pipe are packed with soil. The top end cap has a constant reservoir of water. During the carbon-enhanced biodegradation experiments, an additional 1-foot (30.48 cm) section will be placed between the top end cap and the top three-foot length of pipe to serve as the dosing section for the carbon donor being added to the system. Each column has five ports available for sampling, located at 30 cm, 61 cm, 86 cm, 122 cm, and 178 cm, as measured from the joint between the upper three-foot section and the top end cap. Two primary ports were selected for sampling during the initial bromide tracer test and were labeled A and B as shown in Figure 3-1. Port A for

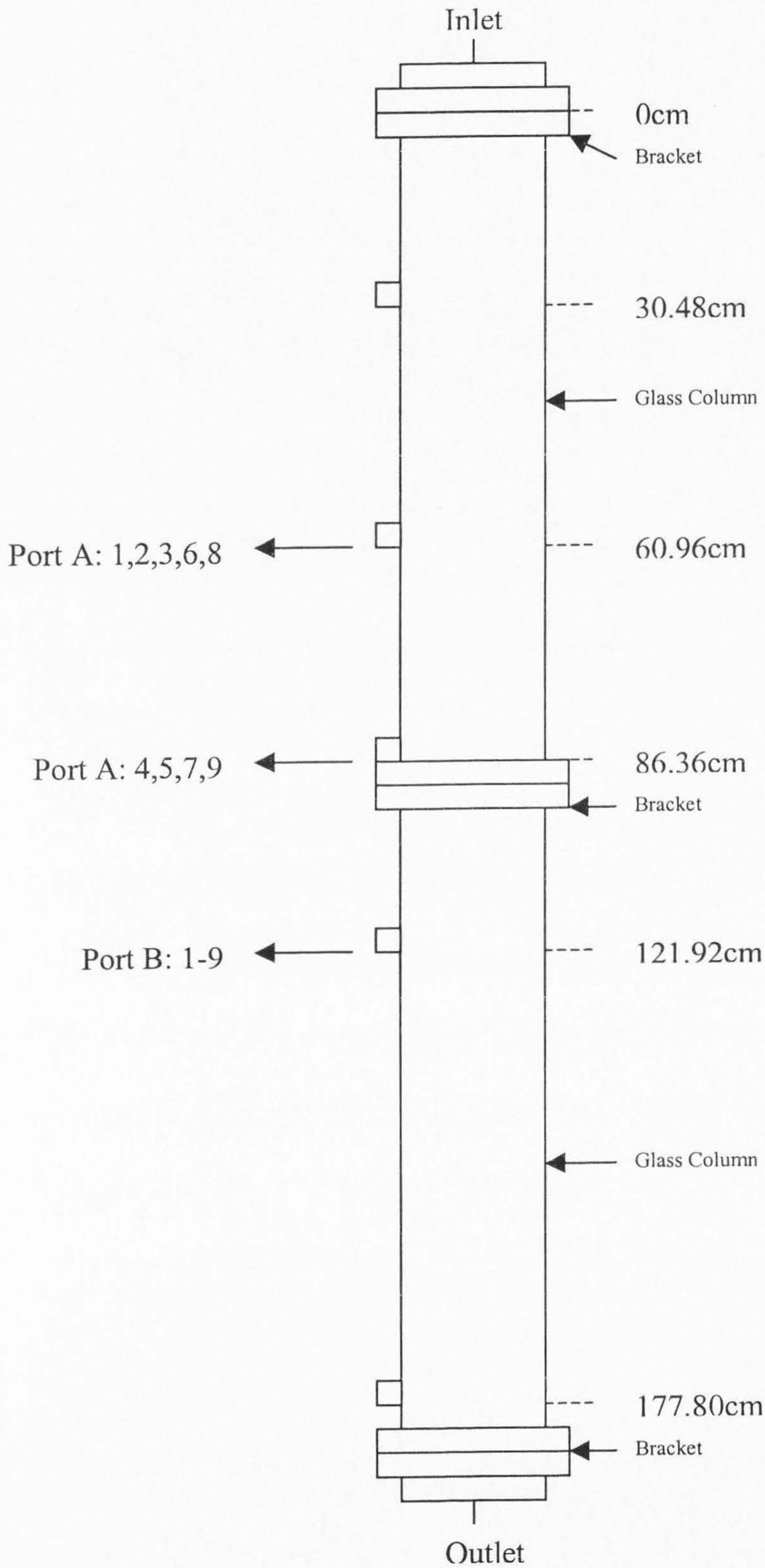


Figure 3-1. Schematic diagram of a column illustrating location and labeling of ports. Not to scale.

Table 3-1. Selected Column Measurements.

	Column Number								
	1	2	3	4	5	6	7	8	9
Glass radius (cm)	7.62								
3-ft section lengths (cm)	91.44								
Top thickness (cm)	3.81								
Base thickness (cm)	12.7	10.795	12.7	11.43	12.7	12.065	11.43	8.89	6.985
Total soil length (cm)	193.6	192.1	193.5	192.2	194.2	192.8	191.2	190.4	187.9
Cross sectional area (cm^2)	182.4								
Soil volume (m^3)	0.0353	0.0350	0.0353	0.0351	0.0354	0.0352	0.0349	0.0347	0.0343

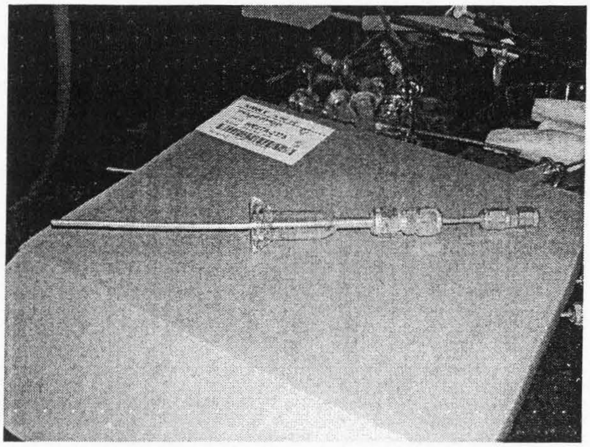
five of the columns was designated as the 61 cm port and the 86 cm port served as Port A for the other four columns. Port B for all nine columns was designated as the 122 cm location. Each sampling port consists of a glass piece, which fits onto the glass column, and a 10-inch (25.4 cm) length of 1/8-inch (0.32 cm) diameter metal tubing, connected together with two brass unions. Figure 3-2 shows two photographs of ports, both alone and inserted into a column. The columns are set up in a dark, temperature-controlled room, held at 16°C.

Soil Preparation

The first batch of soil was collected by Montgomery Watson Harza (MWH) from the Hill AFB Operable Unit 5 property located at approximately 75 West 2125 North in Sunset, Utah, on October 24, 2001. This soil collection site is the same as the groundwater collection site and is designated on Figure 3-3. An auger rig was used to drill several shallow (less than 30 ft or 9.14 m) holes and the soil was collected into 55-gallon drums for transport to the UWRL. After running several preliminary tests, the soil was deemed unsatisfactory for the project because the high clay content made it difficult to push water through the soil column to create the flow-through system desired for the project.

The second batch of soil was collected (also by MWH) from the Nishimoto property located on 2300 North in Sunset, Utah, on December 19, 2001. This soil collection site is designated as such in Figure 3-3. Again, the small auger rig was used to drill several shallow holes with the goal of collecting the coarsest soil material available at the site. The six 55-gallon drums of soil, each approximately half-full from the

A



B

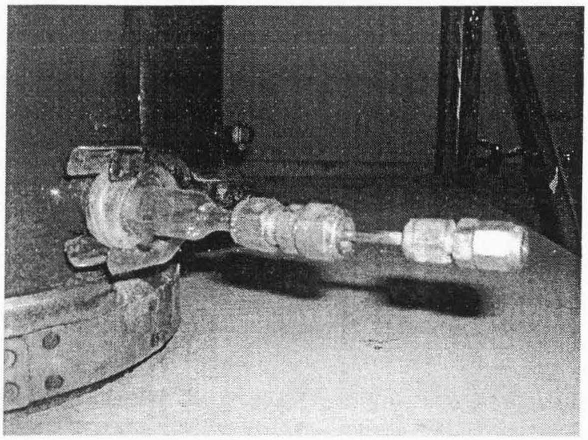


Figure 3-2. Photographs of a sampling port by itself (A) and inserted into a column (B).

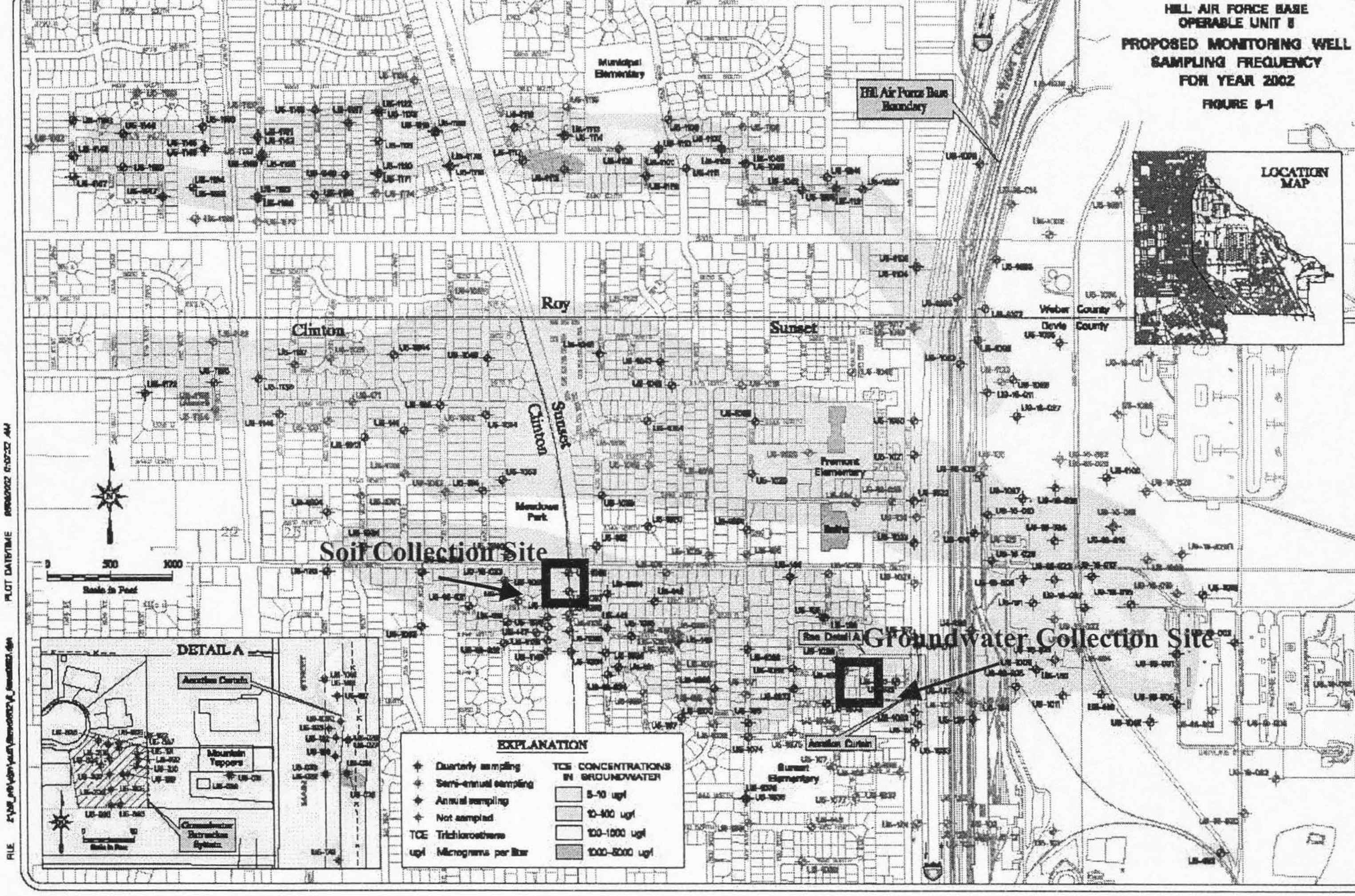


Figure 3-3. Map showing plumes originating on Hill Air Force Base, soil collection site, and groundwater collection site (Montgomery Watson Harza 2002).

several shallow holes drilled with the auger, were mixed together as the first step towards homogenization using a small Bobcat tractor upon their arrival at the UWRL facility. After all the barrels of soil were combined and mixed together, the soil was dried under ventilation hoods, crushed, and sieved through a 2.5 mm sieve.

Soil Packing

In order to ensure accuracy in packing the columns to a bulk density of 1.6 g/cm^3, soil was weighed out and packed in 3-inch (7.62 cm) lifts. Total weight for a 3-inch section was 2224 g. After being weighed, the soil was poured into the 3-foot glass column sections and tamped down with a narrow pointed tool until the surface of the soil was at the correct height marked on the outside of the column section. The sampling ports were inserted into the column sections as the soil reached the height of each port. The bottom end caps differed slightly in their exact height measurements and were packed according to their individual heights to the same bulk density of 1.6 g/cm^3. The bottom end caps were secured to the support structure first, followed by the lower three-foot glass section. Once the lower 3-foot glass section was packed with soil, the upper 3-foot section was added to the structure and packing continued. The top end caps were added to the system following saturation.

Soil Saturation

Following packing of the first whole column, water from a faucet was applied to the bottom cap outlet tube in an attempt to begin the saturation process. Unfortunately, the pressure provided by the water source caused the bottom cap to crack. The weight of the 6 feet of soil was no longer supported and promptly drained onto the floor. Upon closer inspection of the glass caps, it was determined that they were not sufficiently annealed to prevent cracking. After taking additional preventative measures (re-annealing all of the end caps), the nine columns were packed with soil. Water was added via flexible tubing linked from the bottom end caps to reservoirs located at the top of the support structure. Thus, the only pressure applied to the bottom end cap was that of gravity as the water fell along the 6 feet of glass column. Saturation time varied from column to column, some taking up to 4 weeks to saturate the full 6 feet of soil column length. Some of this delay was due to small blockages in the feed tubing that were successfully removed when discovered.

Site Groundwater Collection and Application

Site groundwater was collected as needed (every 4-5 weeks) during the study from the Hill AFB Operable Unit 5 property in Sunset, Utah (well numbers U5-205, U5-206, U5-207, U5-208, and U5-209) in conjunction with representatives from URS Corp. Figure 3-3 shows the location of this groundwater collection site. Groundwater was collected into plastic carboys from the five wells installed at that location. Once back at the UWRL, the water was stored at 4°C until it was needed. Prior to being applied to the columns, each container of groundwater was sparged with nitrogen to purge any TCE present in the water.

Following column saturation with de-ionized water, a peristaltic pump was linked to the top end caps to begin circulating the site groundwater through the columns from top to bottom. Figure 3-4 is a schematic diagram illustrating the fluid circulation and tubing arrangement for a column. As shown in Figure 3-4, the effluent drips at a point

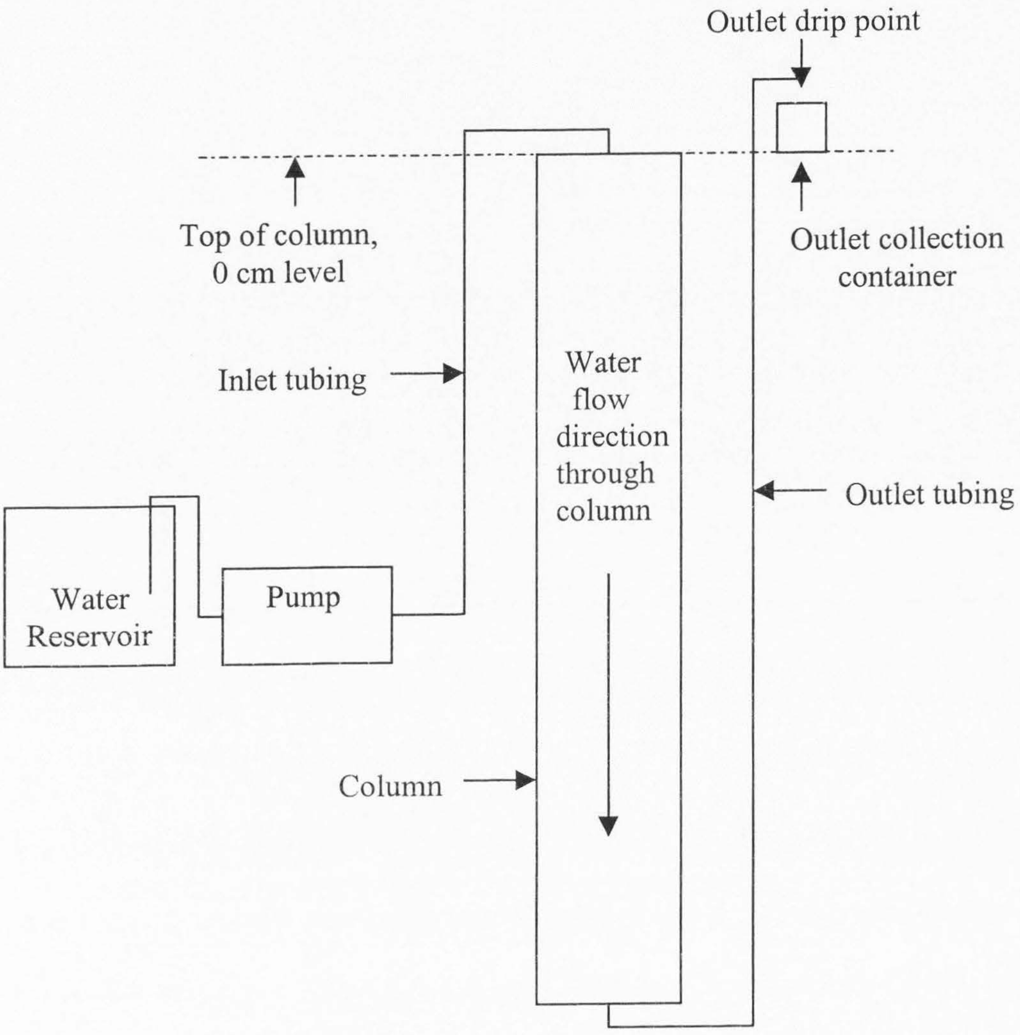


Figure 3-4. Schematic diagram of fluid circulation and tubing arrangement for a column. Not to scale.

above the inlet to the columns. This tubing arrangement was designed to ensure that the columns remained saturated. The top end caps were filled with the site groundwater and kept full during the study. The nitrogen-sparged water served as the reservoir for the peristaltic pump and was circulated at a rate of 1.5 mL/min for a period of approximately 3 weeks to flush three pore volumes through the soil columns. After this period, the rate was decreased to 0.3 mL/min in an attempt to simulate site conditions for the tracer test. It was later discovered that the original Hill AFB Draft Work Plan cited 0.3 mL/min as the site groundwater rate instead of the correct rate of 0.3 ft/day. Following the initial and secondary tracer tests, the pump was reconfigured to feed at the correct field groundwater rate. Figure 3-5 is a photograph of the finished columns with circulation tubing in place and functioning.

Pressure Transducer

A Soil Measurement Systems Tensimeter was used to calculate an estimated hydraulic conductivity value for each column during the study. The pressure was measured each day before samples were taken. The tensimeter measures pressure (or head) in millibars, which are comparable to centimeters of water. This head value was used along with the other parameters below to calculate hydraulic conductivity (K) using Equation 1:

$$K = \frac{QL}{A\Delta h} \tag{1}$$

where Q is the pumping rate (0.3 mL/min), L is the length of the column (average value 191.99 cm), A is the cross-sectional area of the column (182.41 cm^2) and Δh is the pressure head measurement in centimeters minus the height of the effluent tubing as

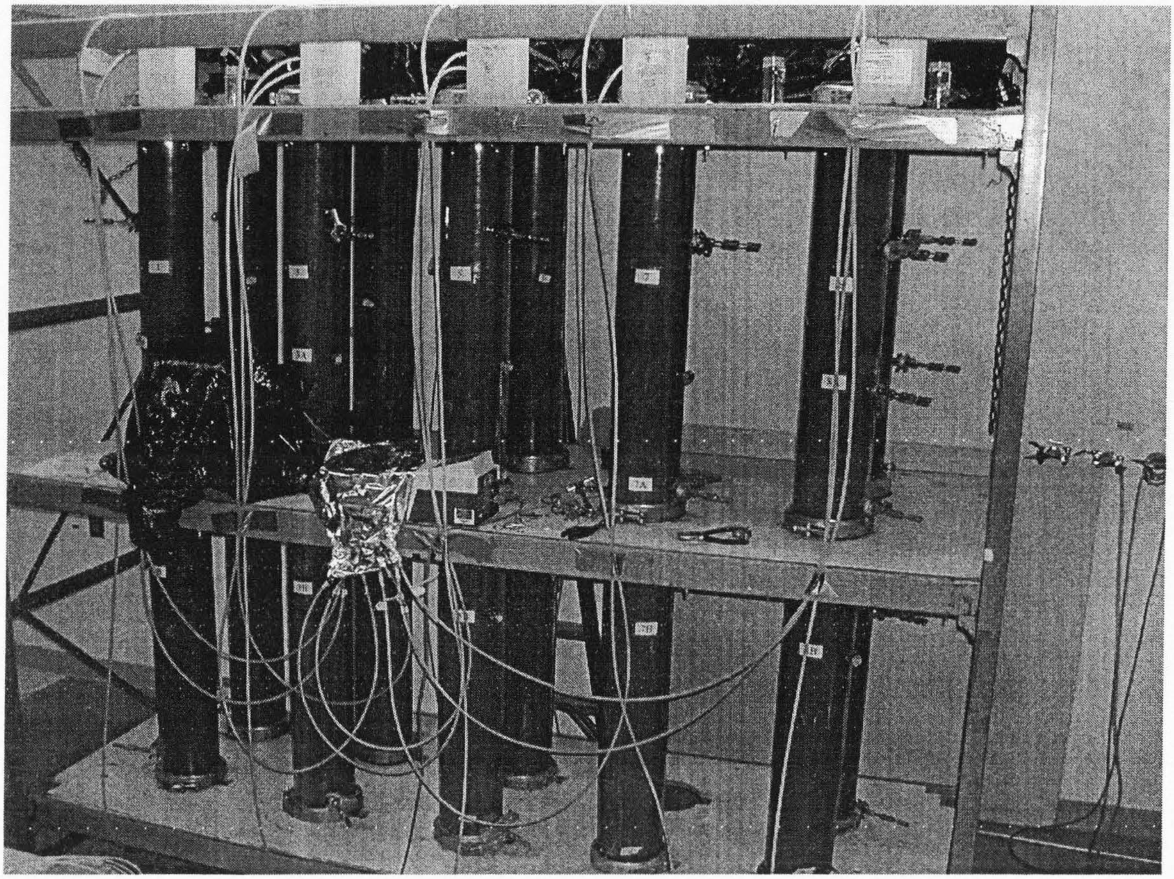


Figure 3-5. Photograph of the finished columns with circulation tubing in place and functioning. The top of the structure, water reservoir, and pump tubing are covered to reduce algae growth. The covering for the top of the structure was removed for the photograph.

measured from the top of the soil. Values of hydraulic conductivity calculated during each bromide tracer test are included in the data section for each test.

Effluent

The effluent tubing ran from the bottom end cap to the top of the support structure. At this height, it dripped into plastic 1000 mL containers. This placement of the effluent outlet above the column inlet, as shown in Figures 3-3 and 3-4, was necessary to ensure that the columns remained completely saturated during the study. Each day, the effluent containers were weighed and emptied. The weight of the water was used to calculate the effluent velocity (v) in the column using Equation 2:

$$v = \frac{\Delta W}{Ant\rho} \tag{2}$$

where ρ is the density of water (1 g/cm^3), ΔW is the weight of the container with effluent minus the weight of the container empty in grams, A is the cross-sectional area of the column (cm^2), n is the porosity, and t is time in days since the containers were last weighed and emptied. Values of effluent velocities calculated during each bromide tracer test are included in the data section for each test.

Discussion

Column Structure

The design of the columns has several flaws which were only discovered when the columns were being constructed and prepared for the initial bromide tracer test. First, the soil available at the site in Sunset, Utah, is not ideal for column flow-through studies. The fine-grained nature and high silt/clay content of the soil made homogenization difficult and resulted in small discrepancies, such as peak day, in results among columns even though they were all constructed identically and were running at the same water circulation pumping rate. Several ports were neither air- nor water-tight and experienced water leakage during the first few weeks of site groundwater circulation. Several methods were employed in attempts to stop or slow the port leakage, such as plumbers putty and parafilm, in addition to tightening the port clamps as much as possible. Most of the leaks were ultimately eliminated by removing the sampling port and inserting a rubber stopper in the glass opening. This reduced the number of ports available for sampling, but corrected the leakage problems and ensured that the system could be kept in an anaerobic state.

CHAPTER 4

FIRST BROMIDE TRACER TEST

Methods

Creation and Application of Solution

The bromide tracer solution was made by mixing 22 L of nitrogen-sparged site groundwater with 14.168 g of crystalline sodium bromide (NaBr). This resulted in a bromide solution with an average concentration of 574 mg/L and an average electrical conductivity (EC) of 1630 μS/cm. The concentration of the bromide tracer solution was also measured at the inlet of each column at the start of the test for a more accurate representation of the solution entering individual columns. A bromide tracer solution concentration of approximately 500 mg/L was selected because it sufficiently outweighed the background concentrations of bromide in the soil and site groundwater, and because it was within the measurable range of the bromide-specific electrode.

The first bromide tracer test began on May 26. Several activities were involved in applying the pulse in order to ensure that the change was as sharp as possible. Each column was handled individually and the start time for each was recorded. The top end cap was drained by suction of all water being stored in that volume. Then the top end cap was refilled with the bromide tracer solution. Once the cap was full, the tubing linked to the peristaltic pump was reconnected and began feeding bromide tracer solution into the top end cap, and thus the column. The bromide tracer solution was allowed to feed the columns for a period of 3 days at a rate of 0.3 mL/min. On May 29, each column was switched back to site groundwater to end the 3-day pulse. The exact times of the application and removal of the tracer pulse are available in Table A-1 in Appendix A. Again, the same methods described above were used to ensure a sharp change from bromide tracer solution to site groundwater. The top end cap was drained of the bromide tracer solution, refilled with nitrogen-sparged site groundwater, and reconnected to the pump feeding the site groundwater. The site groundwater continued to be circulated at 0.3 mL/min until the final sampling day on July 26.

Sampling

In order to properly submerse the probes during analysis, at least 20 mL of water were needed to analyze for bromide concentration and electrical conductivity. The original setup used Lure-Lok equipped syringes to pull the water from Ports A and B. Unfortunately, this method failed to exert enough suction to pull the water out of the soil. Several methods were tested in the search for an effective sample removal technique from the ports. The most effective method found for sampling from Ports A and B required a Soilmoisture Equipment Vacuum Test Hand Pump shown in Figure 4-1. The pump was connected to a small (125 mL) bottle, which in turn could be connected to the port being sampled on the column. A weak vacuum (10-20 centibars) was created using the pump and approximately 20 mL of water were pulled into the bottle from the column and transferred to a 40 mL vial for analysis. Three bottle and pump arrangements were created and were rinsed thoroughly with de-ionized water between samples. Outlet samples were collected in a much simpler manner. The tubing attached to the bottom end cap was clamped off (to prevent pressure loss and drainage in the effluent tubing) and disconnected from the glass outlet. A sample vial was placed underneath the

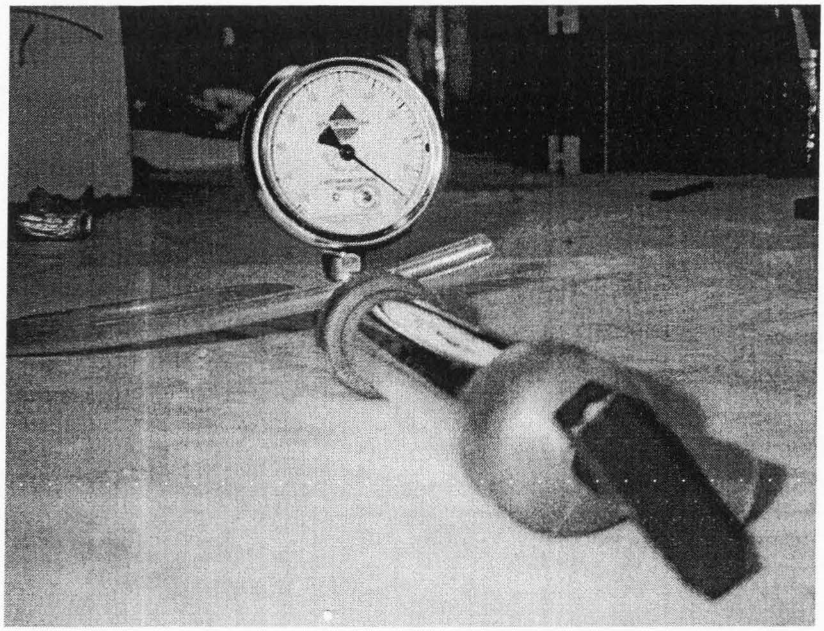


Figure 4-1. Vacuum hand pump for removal of samples from Ports A and B.

glass outlet to catch the drips of water as they exited the column. After the sample had been collected, the tubing was reattached to the bottom end cap and unclamped to allow effluent flow again. Sample vials for all ports were immediately capped and labeled with the date, time of day, column number, and port location. Samples were placed with the bromide selective electrode in the laboratory to reach room temperature for analysis.

Analytical Methods

Analysis of the water samples was a two-part process. First, 20 mL was measured and placed into large test tubes. Each sample was analyzed for electrical conductivity using a Fisher Scientific Accumet Model 30 EC meter. Next, the 20 mL sample was transferred into a small cup to accommodate the dual probe system associated with the bromide analysis. A small amount (0.4 mL) of Ionic Strength Adjustor (ISA) was added to the sample to create a high background ionic strength that remained constant relative to the variable concentration of bromide among the samples. Each sample was analyzed for bromide concentration using an Orion Model 9435 bromide specific electrode. All measurements were recorded by hand and later entered into the computer database files. The bromide probe was calibrated before each use using four standards of 0.8 mg/L, 8.0 mg/L, 80 mg/L, and 800 mg/L, made by doing a 10:100 dilution from the next highest standard. All standards included ISA and standard slopes were between 90 and 100. The probe results are reproducible ± 2% when calibrated once during every hour of use.

Modeling with CXTFIT

The CXTFIT, Version 2.1, computer program was selected for the purpose of modeling the bromide BTCs (Toride et al. 1995). There are two main options in the program, the direct problem and the indirect problem, which were employed during this study.

The direct problem method served to give predictive models, which yielded a relative concentration versus time BTC using estimated velocity and dispersion values. Before applying the pulse, several predictive models were created to estimate the length of time for the tracer test and the retention time or time when the pulse peak would pass by the outlet location. Velocity was estimated to be 4.7 cm/day using the circulation rate of 0.3 mL/min (432 cm^3/day), the cross-sectional area of the column (182.4 cm^2), and an estimate of soil porosity (0.50) using Equation 3:

$$v = \frac{Q}{An} \tag{3}$$

Dispersion was estimated by using a statistical plot (Figure 4-2) to have a value equal to one-tenth of the soil length, 18.3 cm^2/day.

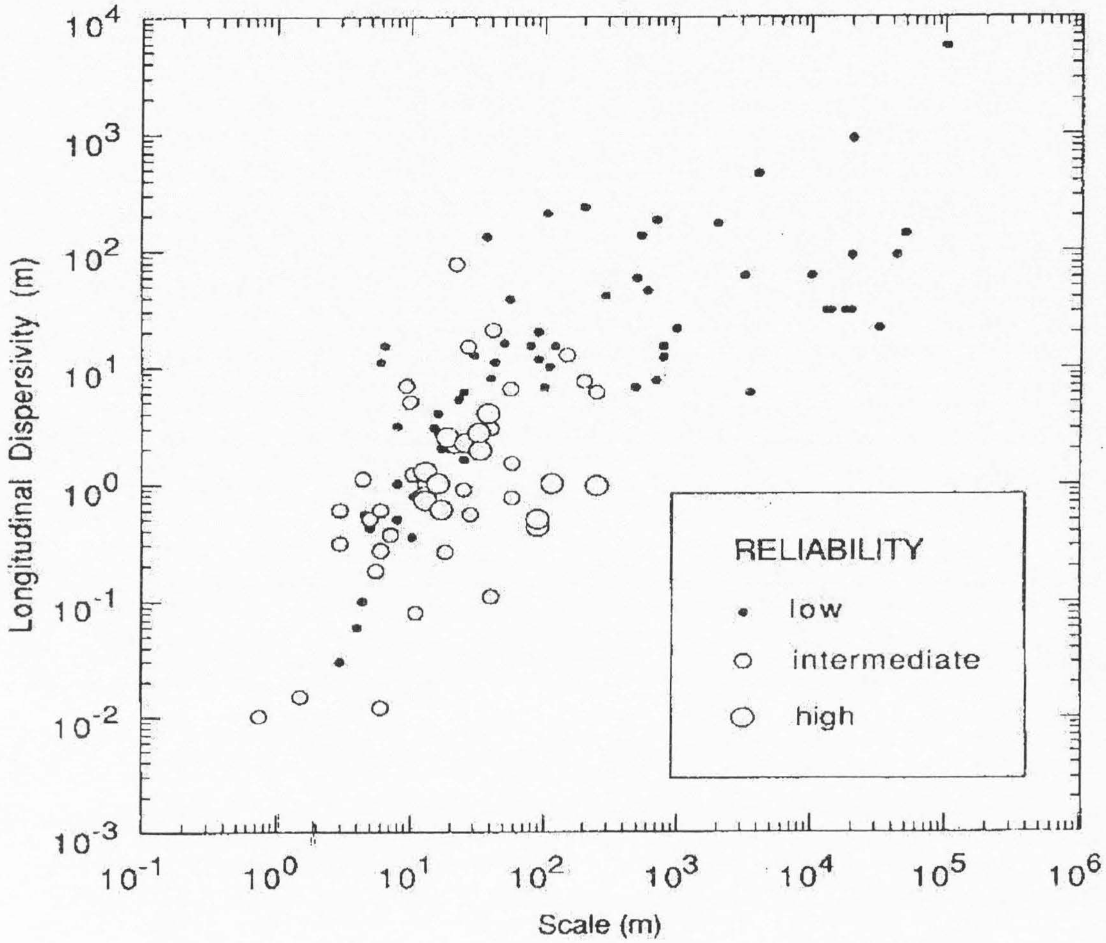


Figure 4-2. Statistical plot for estimation of dispersion. (From Gelhar et al. 1992)

The indirect problem method in the program was used for fitting the observed data. With the indirect problem, the values observed for relative concentration and time are entered into the program along with the estimated velocity and dispersion values. The program then fits the observed data as closely as possible, giving a coefficient of determination (r^2) value as a check on data fit. The velocity and dispersion are re-calculated using these fitted data values to represent the velocity and dispersion values that occurred with the observed data. The indirect problem illustration shows the observed data BTC along with the fitted data BTC on one plot of relative concentration versus time. The initial velocity and dispersion estimates entered in the program were 4.7 cm/day and 18.3 cm^2/day, respectively.

Predictive Modeling

Using the original estimated velocity and dispersion parameters, the model predicted that the pulse was expected to have a spread of approximately 39 days, and that the peak would pass the outlet location 40 days after the pulse was applied to the columns. Figure 4-3 is a graph illustrating the output from this predictive model. The highest relative concentration value obtained in this model is 0.15.

Since the soil is so fine-grained, it was expected that discrepancies would exist and that the data would not fit one model accurately. The second predictive model used a dispersion value of 1.83 cm^2/day, one order of magnitude less than the original. predictive model. The resulting BTC in Figure 4-4 shows a peak relative concentration of 0.44 on the 42nd day of the tracer test with a pulse spread of about 13 days.

Alteration of the velocity parameter estimate created two other models to compare against the first shown in Figure 4-3. The original estimate of 4.7 cm/day was based on a porosity of 0.50. Velocity estimates using porosities of 0.30 and 0.40 were put into the model and graphed along with the original dispersion estimate of 18.3 cm^2/day. These velocity values were 7.9 cm/day and 5.9 cm/day, respectively. The resulting BTCs are shown in Figure 4-5. Two models were also run for a dispersion estimate of 1.83 cm^2/day as a comparison to the second predictive model (Figure 4-4) that used this dispersion estimate with the original velocity estimate. Figure 4-6 shows these two additional BTCs. Table 4-1 summarizes information from the six predictive models.

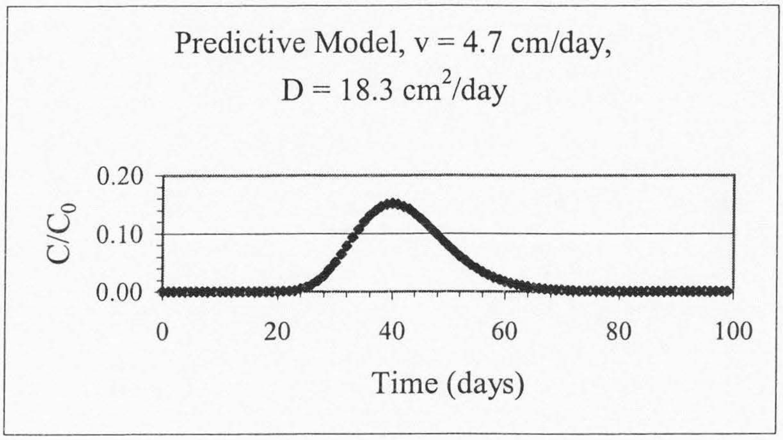


Figure 4-3. CXTFIT predictive model using v = 4.7 cm/day (n = 0.50) and D = 18.3 cm^2/day, May 26.

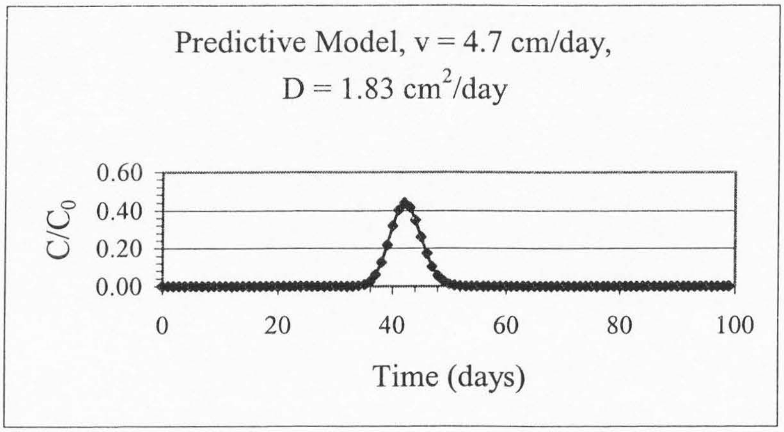
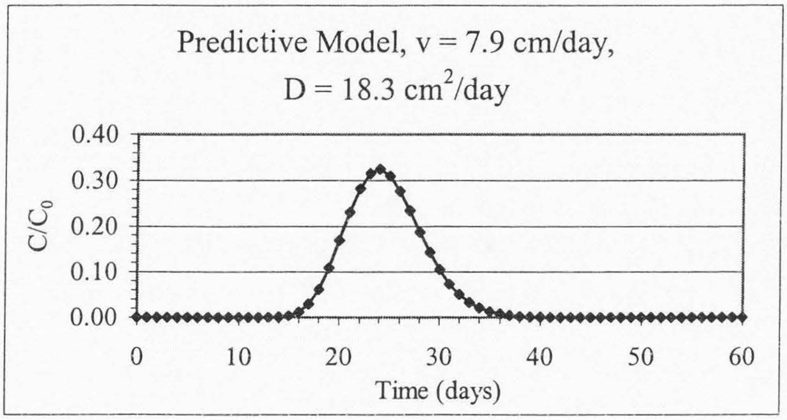


Figure 4-4. CXTFIT predictive model using v = 4.7 cm/day (n = 0.50) and D = 1.83 cm^2/day, May 26.

A



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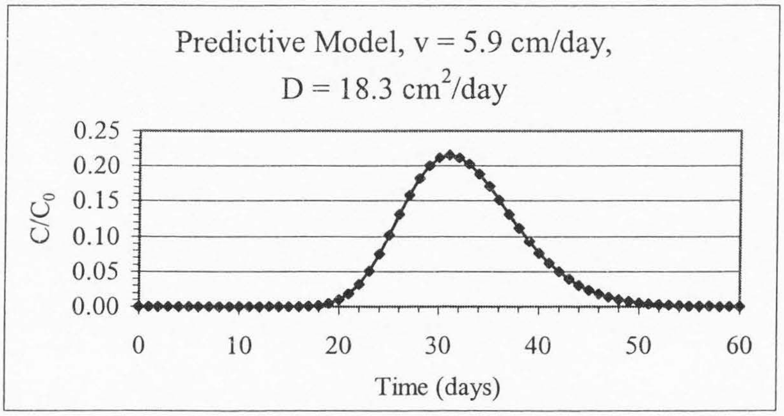
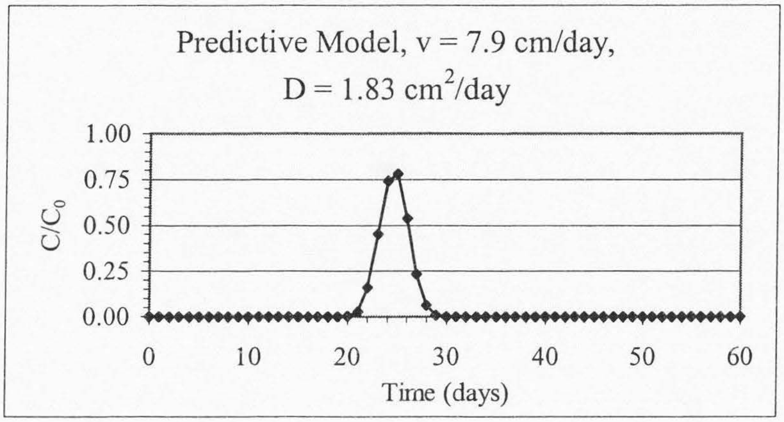


Figure 4-5. CXTFIT predictive model using D = 18.3 cm^2/day and varying porosities, May 26. A) n = 0.3 B) n = 0.4.

A



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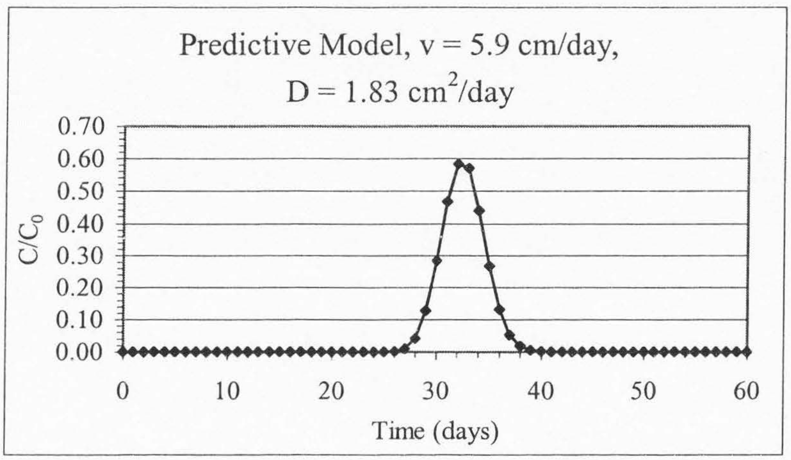


Figure 4-6. CXTFIT predictive model using D = 1.83 cm^2/day and varying porosities, May 26. A) n = 0.3 B) n = 0.4.

Table 4-1. Summary of Predictive Model Data, May 26. Peak Day, Peak Relative Concentration, and Pulse Duration for the Six Predictive Models Using Varying Values of Porosity and Dispersion.

Velocity and Dispersion Estimate Used	C/C_0 Peak	Peak Day	Pulse Duration
v = 4.7 cm/day, D = 18.3 cm^2/day	0.15	40	39 days
v = 4.7 cm/day, D = 1.83 cm^2/day	0.44	42	13 days
v = 5.9 cm/day, D = 18.3 cm^2/day	0.22	31	30 days
v = 7.9 cm/day, D = 18.3 cm^2/day	0.32	24	20 days
v = 5.9 cm/day, D = 1.83 cm^2/day	0.58	32	10 days
v = 7.9 cm/day, D = 1.83 cm^2/day	0.78	25	10 days

Hydraulic Parameter Data

Hydraulic Conductivity

When the tracer study began on May 26, the first head values were measured using the Soil Measurement Systems Tensimeter. Several columns took a while to reach steady state and therefore had negative head values. By June 23, every column had a constant, positive head value and the hydraulic conductivity of the soil could be calculated using Equation 1. Table 4-2 summarizes the averages of input parameters associated with the hydraulic conductivity values. Two hydraulic conductivity (K) values are given in Table 4-2. The first shows values calculated using the average tensimeter reading over the entire length of the tracer test. The second shows an average of the K values calculated on a daily basis, not including those daily K calculations that had negative values, as they are suspected to be inaccurate and not credible. The averages of

Table 4-2. Summary of Averages of Input Parameters Associated with the Hydraulic Conductivity Values, May 26.

Column Number	1	2	3	4	5	6	7	8	9
Avg. Tensimeter Value (cm H_2O)	42.56	24.09	48.50	32.00	27.03	33.47	22.97	46.82	34.32
Height of Effluent Tubing (cm)	18.5	15.5	19.5	19.0	17.5	19.0	21.5	19.0	17.5
Soil Length (cm)	193.6	192.1	193.5	192.2	194.2	192.8	191.2	190.4	187.9
K Using Average Tensimeter Value (cm/day)	19.06	52.97	15.80	35.01	48.26	31.55	307.92	16.21	26.45
Average of Daily Calculated K Values w/out negatives (cm/day)	19.71	59.06	16.06	44.30	47.89	32.12	434.88	18.37	27.14

the daily-calculated hydraulic conductivity values more accurately reflect conditions in the columns because they take into account small daily fluctuations in pressure head. The bulk average is unable take these fluctuations into account because it is based on an average tensimeter measurement over the entire testing period. The complete data set for tensimeter measurements and hydraulic conductivity calculations can be found in Tables A-2 and A-3 in Appendix A.

Velocity

The negative head values obtained with the tensimeter generally indicated that the effluent was not dripping into the collection containers. Therefore, as with the hydraulic conductivity, accurate velocities could not be calculated prior to late-June. Table 4-3 shows the input parameters and the average velocities calculated using Equation 2 for

Table 4-3. Average Velocity Measured by Effluent Flow from June 30 to July 26.

Column Number	1	2	3	4	5	6	7	8	9
Total Weight (kg)	9.68	5.71	10.24	9.75	7.45	10.09	10.02	9.78	9.72
Total Time (day)	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79
v Using Total Weights and Times (cm/day)	3.82	2.25	4.04	3.85	2.94	3.98	3.95	3.86	3.84
Average of Daily Calculated v Values (cm/day)	3.85	2.26	4.04	3.84	2.96	3.98	3.95	3.86	3.83

each column from June 30 to the end of sampling on July 26 for this initial tracer test. Two sets of velocity data are shown in Table 4-3. The first shows velocities calculated with the bulk sums of water weights and time. The second shows an average of the velocity values calculated on a daily basis during the tracer test. The porosity used in these calculations was 0.50. As with the hydraulic conductivity, the daily averages are more accurate representations of the true velocities in the columns and are thus used later in comparison to the CXTFIT model calculated velocities. All effluent weight data and daily-calculated velocities can be found in Appendix A as Tables A-4 and A-5.

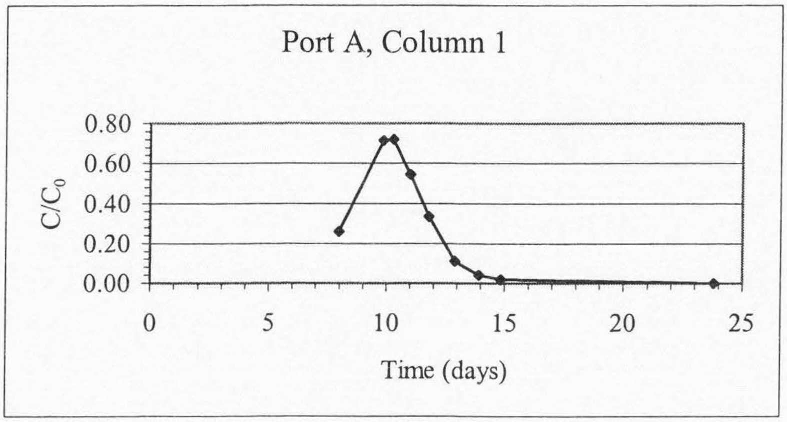
Bromide Concentration Data

A complete listing of the data compiled for Ports A, B, and the outlet can be found in Tables A-6, A-7, and A-8, respectively, in Appendix A. Presented below is a summary of the data in the form of the observed data BTCs for each of the three sampling locations and each of the columns.

Port A

Port A was the first port sampled during this bromide tracer test. Several samples were taken over the course of the first 20 days and were analyzed for electrical conductivity (EC) and bromide concentration. Ideally, only one of the three sampling ports in the upper 3-foot column section was to be utilized during sampling. Unfortunately, clogging of several ports required a switch during sampling from one port to another, as shown in Table A-6. Only the measurements taken from the final port location are included in the data presentation and analysis for each column. Column 1 began with one sample from the 61 cm port, followed by two from the 86 cm port, and made its final switch to the 61 cm port on June 3. Column 4 began with five samples taken from the 61 cm port and was switched permanently to the 86 cm port on June 5 for the final 11 samples. Columns 5, 7, and 9 were switched to the 86 cm port on May 30 after two samples had been taken from each of their 61 cm ports. Columns 2, 3, 6, and 8 were sampled only at the 61 cm port location. In the end, five columns used the port at 61 cm and four used the port at 86 cm. All sampling port locations are shown in Figure 3-1. Because it was difficult to remove samples from this port, the BTCs are not all complete. Several are missing the "tail" section of the curve. The columns whose sampling port location was switched during the sampling period (1, 4, 5, 7, and 9) are also missing the approaching leg of the BTCs. Figure 4-7 shows the unfitted BTCs for Port A for all nine columns. The limited sampling did provide more accurate estimates of velocity and dispersion (during subsequent modeling). Table 4-4 summarizes the number

A



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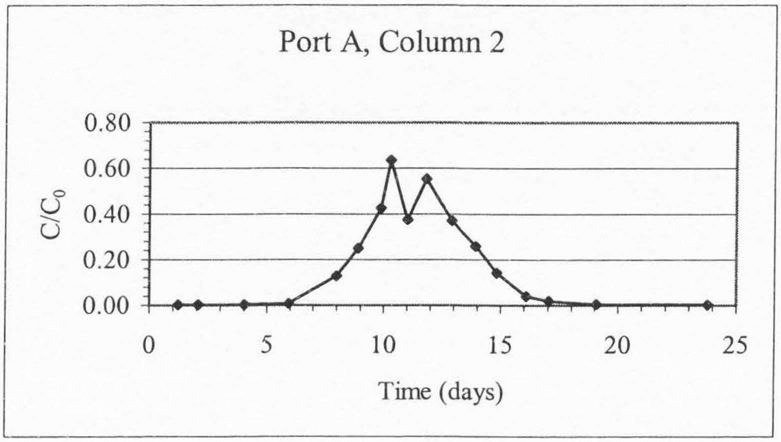

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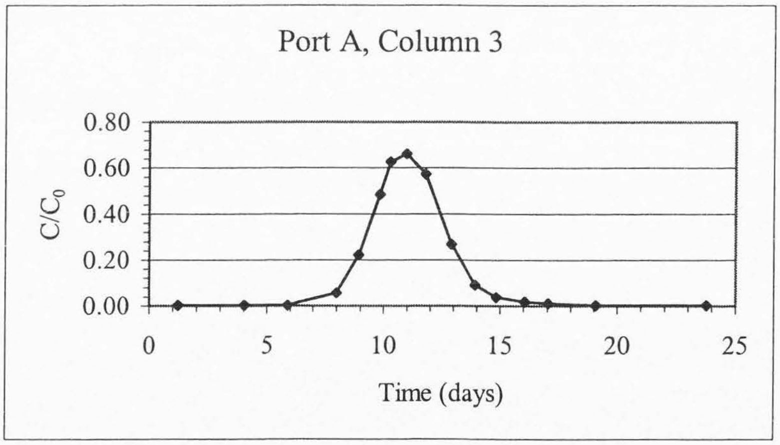
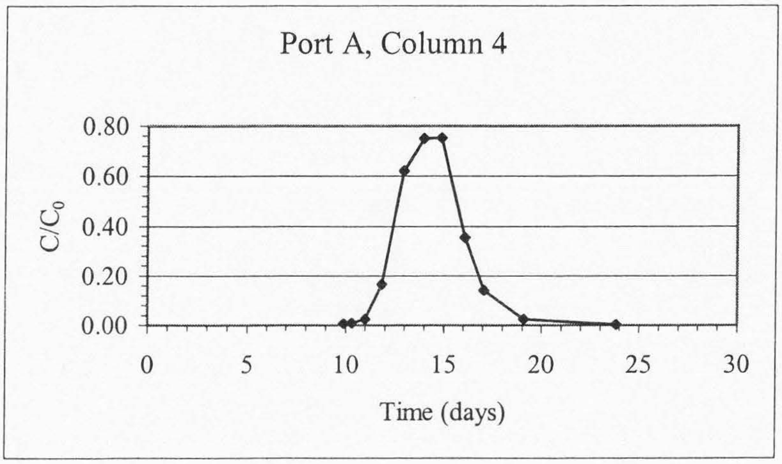


Figure 4-7. Unfitted BTCs for Port A, May 26. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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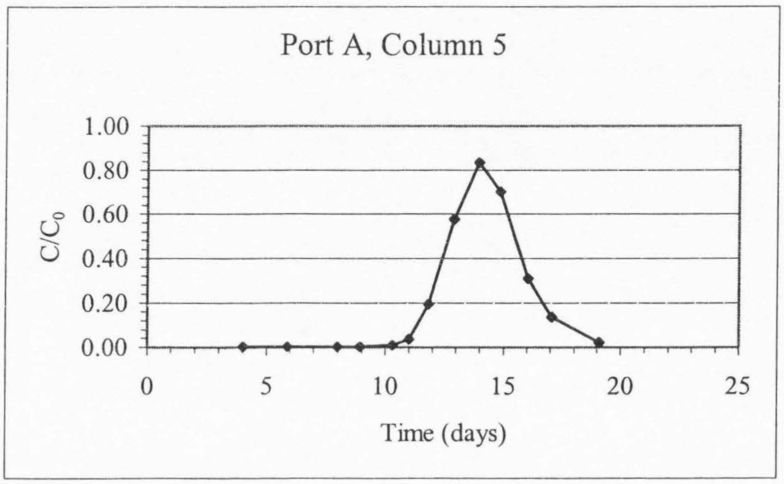

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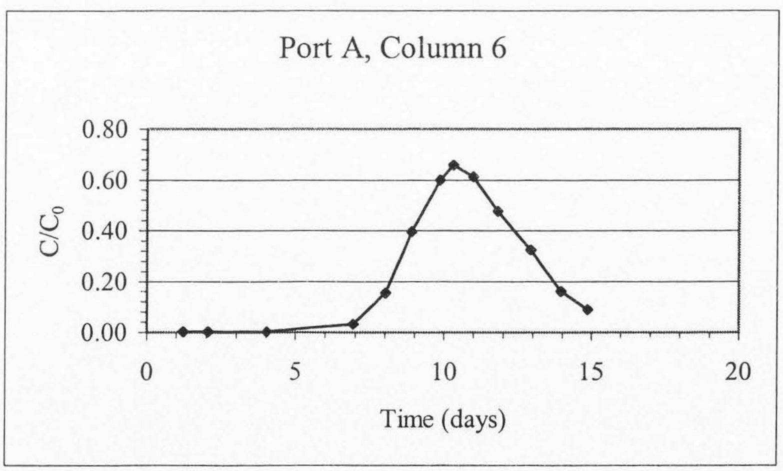
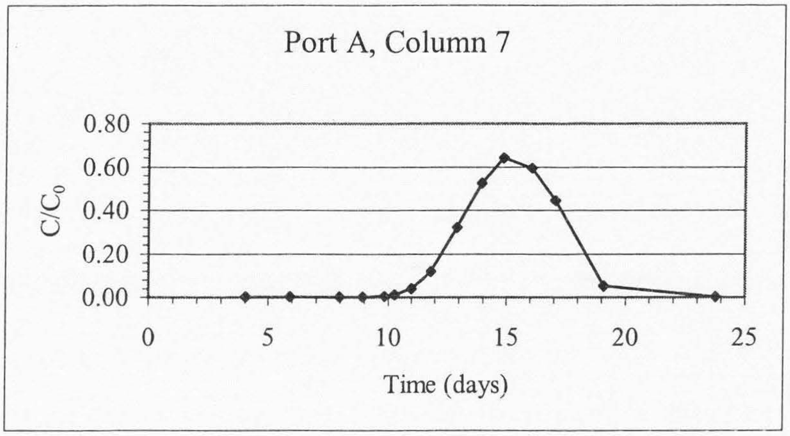


Figure 4-7. (Continued)

G



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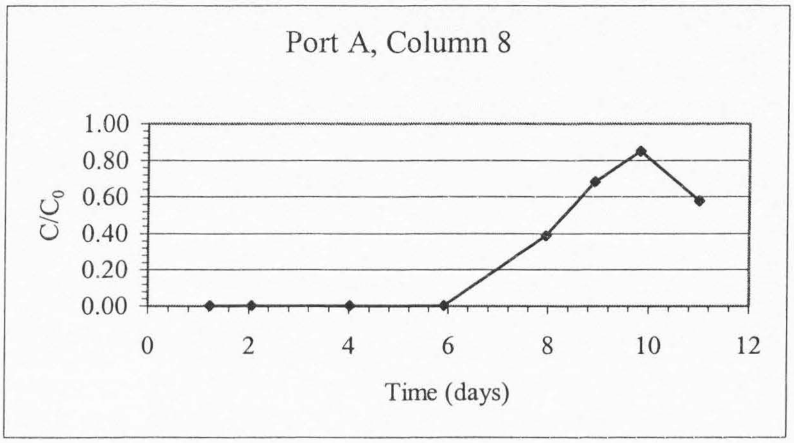

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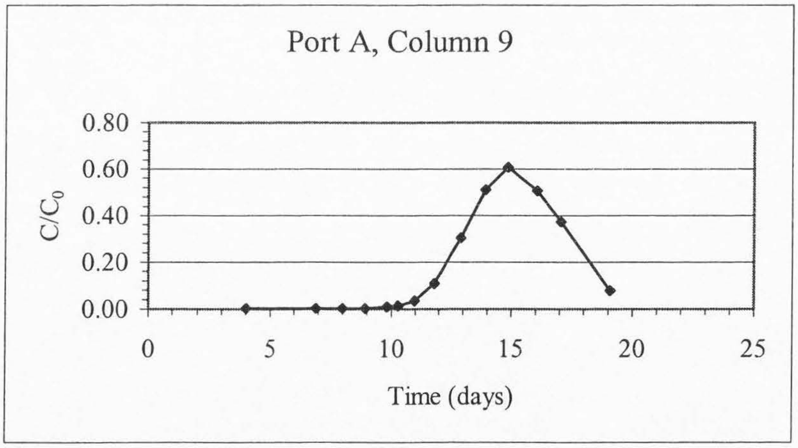


Figure 4-7. (Continued)

Table 4-4. Summary of Port A Data Pertaining to BTCs, May 26. Port A Located at Either 61 cm or 86 cm.

Port Location 61 cm						
Column Number	1	2	3	6	8	Avg.
Samples Used for Analysis	9	17	16	13	8	12.6
Peak Day	10.30	10.30	10.97	10.31	9.83	10.34
Peak C/C_0	0.72	0.63	0.66	0.66	0.85	0.70

Port Location 86 cm					
Column Number	4	5	7	9	Avg.
Samples Used for Analysis	11	13	15	14	13.3
Peak Day	14.86	13.94	14.85	14.86	14.63
Peak C/C_0	0.75	0.84	0.64	0.61	0.71

of samples taken from each Port A, peak relative concentration, and peak day or retention time.

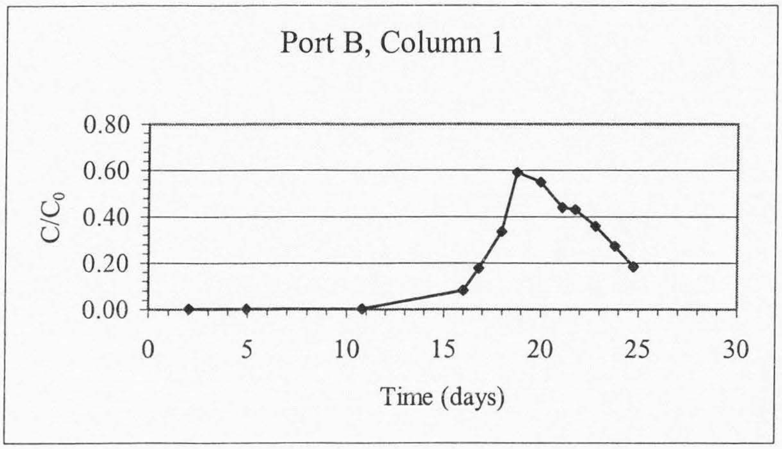
Port B

Port B was the second place samples were taken during the bromide tracer test. Daily sampling began on June 11. Sampling prior to June 11 was sporadic in both location and frequency, as shown in Table A-7, because the decision to use only one of the two sampling ports available in the lower 3-foot section of column had not yet been made. Columns 1, 2, 3, 6, and 9 were sampled only from the 122 cm port for the entire duration of the tracer test. Columns 4 began with one sample from the 122 cm port followed by four samples at the 178 cm port. Column 5 was switched to the 122 cm port after four samples had been taken from the 178 cm port. The final seven samples for Column 4 and six samples for Column 5 were collected from the 122 cm port. Columns 7 and 8 each had five samples from the 178 cm port. Column 7 finished with five samples from the 122 cm port while Column 8 finished with four samples from the 122 cm port. All of the samples used for analysis for each column have Port B located at the same position, 122 cm. Just as with Port A, the sampling provided preliminary BTCs, but sampling was discontinued before the BTCs could be completed. Columns 2, 5, and 7 were not sampled for a long enough period of time and do not show peak concentrations. Because they experienced no tracer pulse peak, no retention times are available for these columns at the 122 cm port location. Figure 4-8 shows the unfitted breakthrough curves for Port B in all columns using only the final samples collected from the 122 cm port. Table 4-5 summarizes the significant data about the BTCs for Port B, including retention times (peak days) and peak relative concentrations.

Outlet

The last sampling location was the outlet at the bottom of the columns. Many more samples were collected from this location in order to create a complete breakthrough curve. Table 4-6 summarizes information about the BTCs for the outlet location. Figure 4-9 shows all nine outlet BTCs on one plot of relative concentration versus time. Figure 4-10 shows the individual curves in more detail by themselves. The BTCs for the outlet location clearly illustrate the movement of the bromide tracer as it

A



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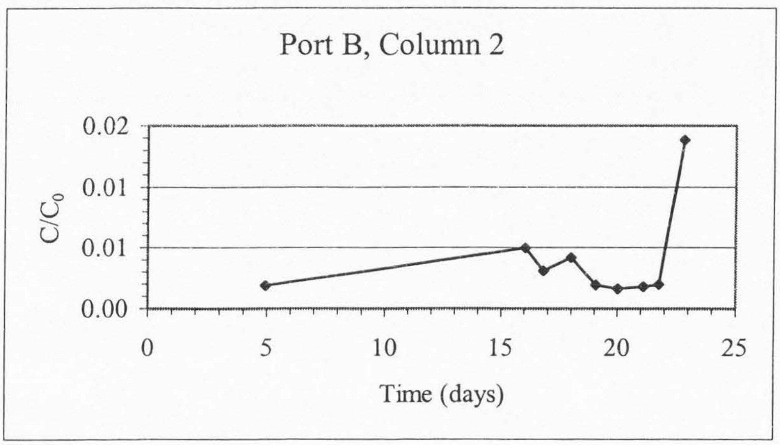

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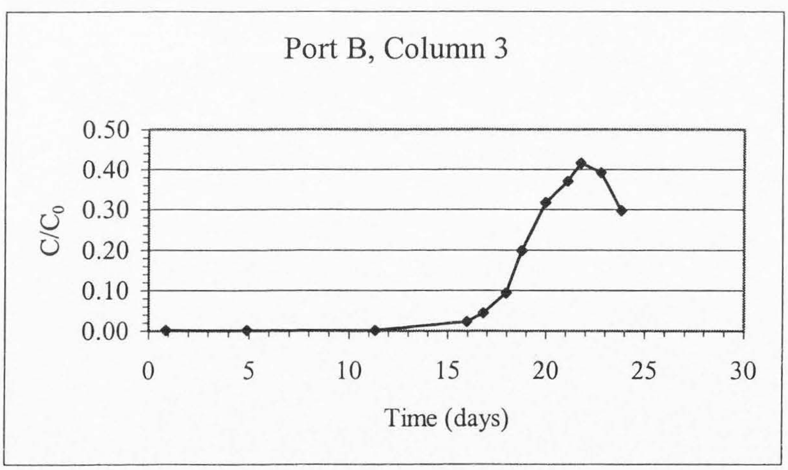
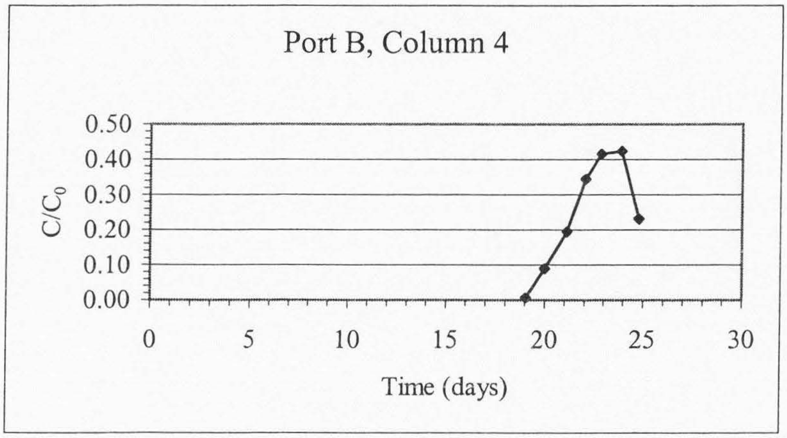


Figure 4-8. Unfitted BTCs for Port B, May 26. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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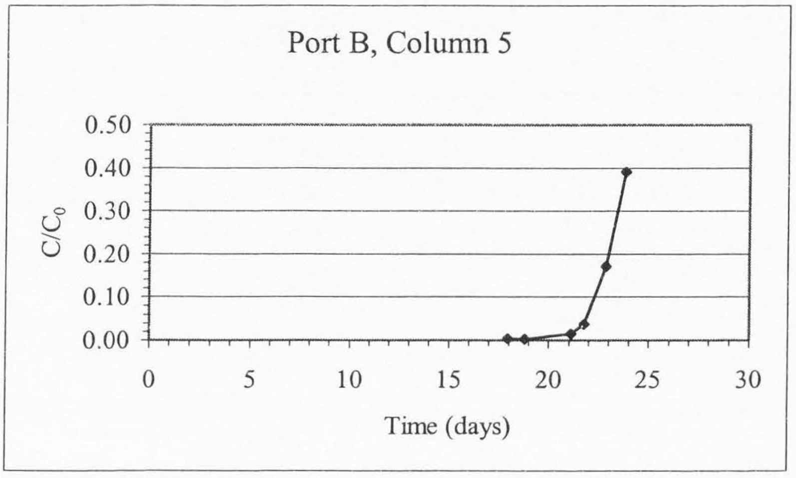

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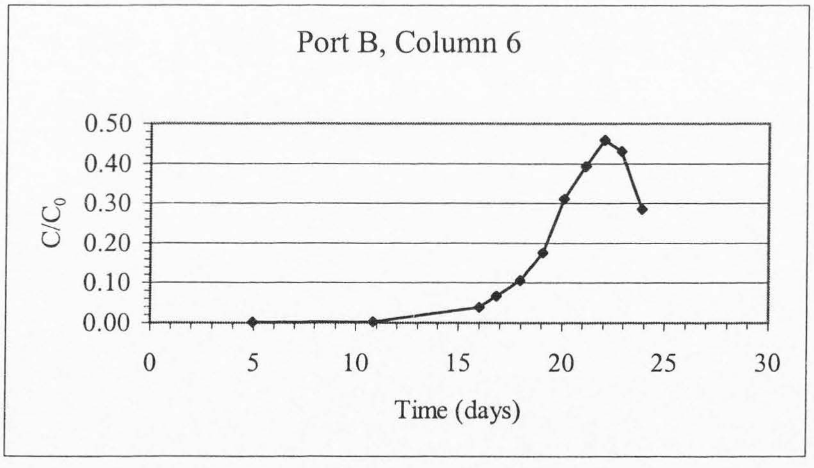

Figure 4-8. (Continued)

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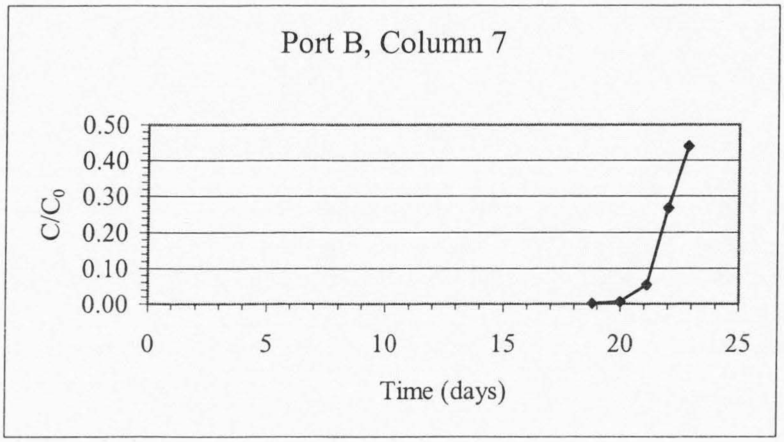

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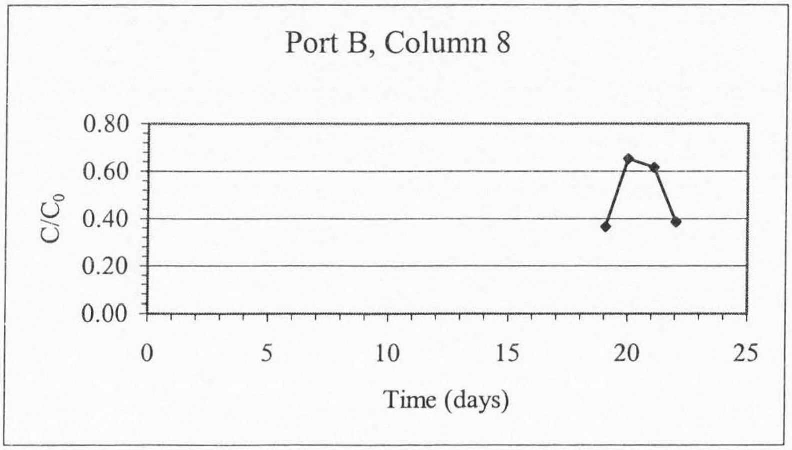

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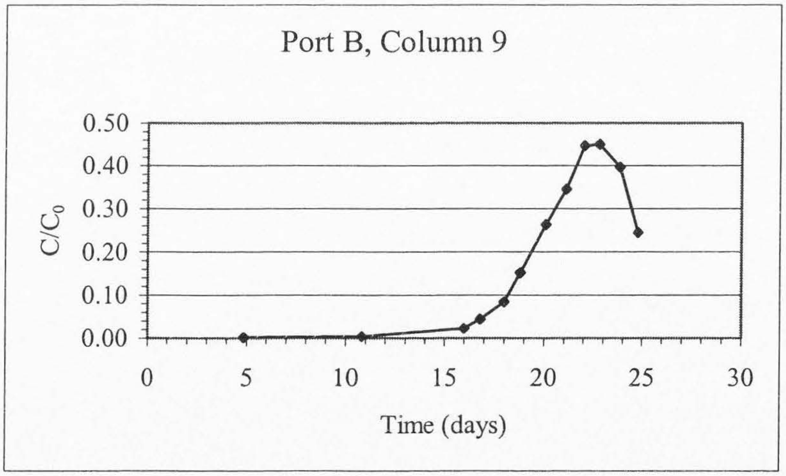

Figure 4-8. (Continued)

Table 4-5. Summary of Port B Data Pertaining to BTCs, May 26. All Columns Have Port B Located at 122 cm.

Column Number	1	2	3	4	5	6	7	8	9	Avg.
Samples Used for Analysis	13	9	12	7	6	11	5	4	12	8.78
Peak Day	18.78	no peak	21.76	23.88	no peak	22.02	no peak	20.00	22.78	21.54
Peak C/C_0	0.59	no peak	0.42	0.42	no peak	0.46	no peak	0.65	0.45	0.50

Table 4-6. Summary of the Outlet Data Pertaining to BTCs, May 26.

Column Number	1	2	3	4	5	6	7	8	9	Avg.
Samples Taken	59	66	58	59	61	59	58	58	59	59.67
Peak Day	35.68	47.85	33.83	33.83	39.15	33.05	34.15	30.76	30.93	35.47
Peak C/C_0	0.18	0.11	0.25	0.14	0.24	0.32	0.13	0.44	0.31	0.24

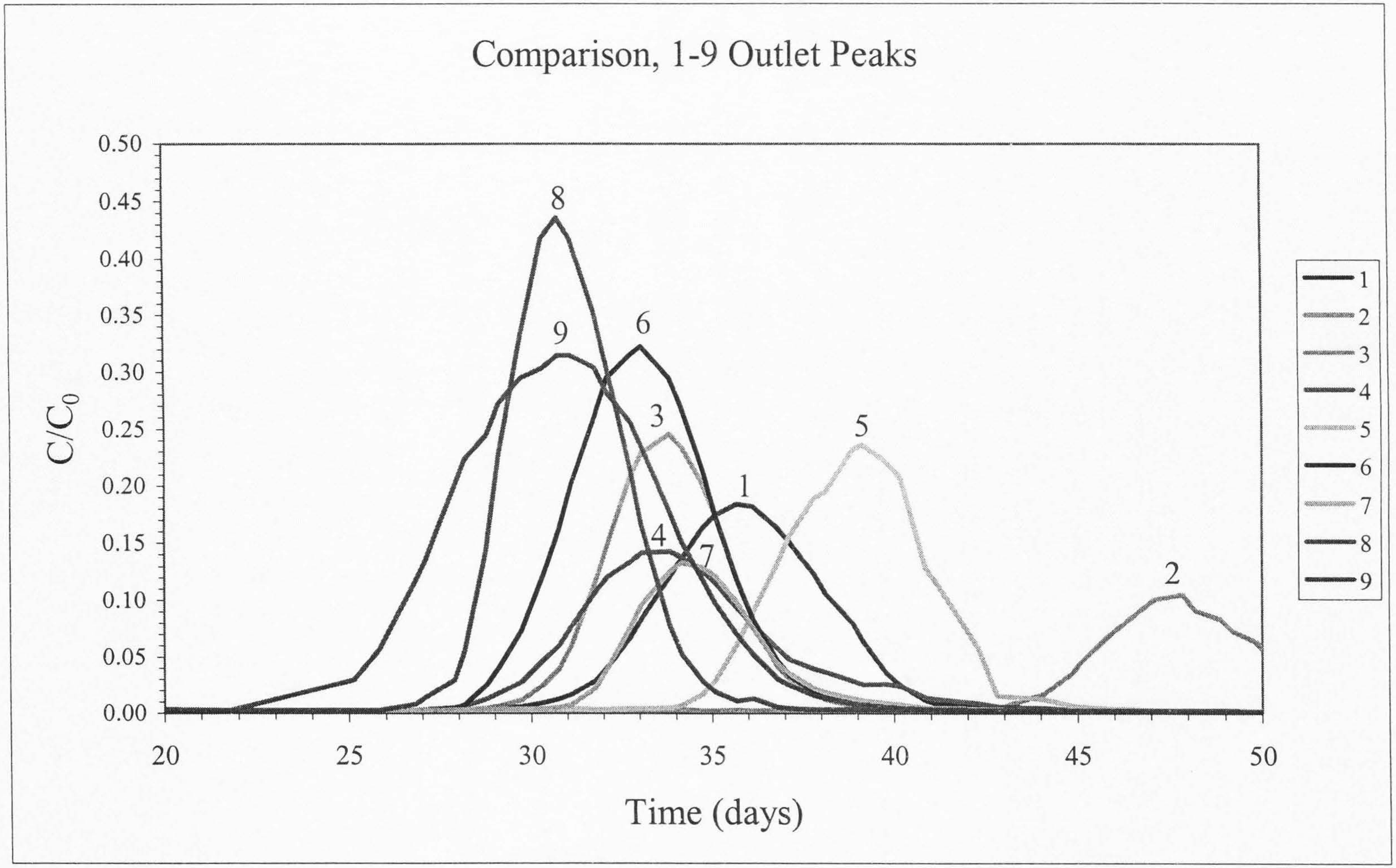

Figure 4-9. Unfitted BTCs for all nine columns at the outlet location, May 26.

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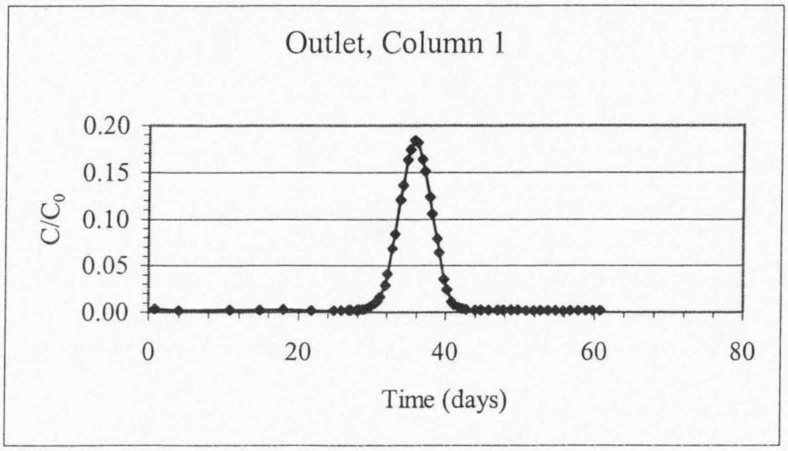

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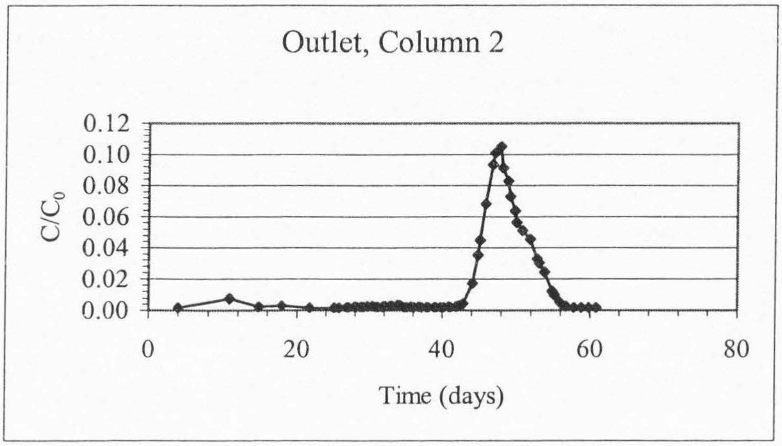

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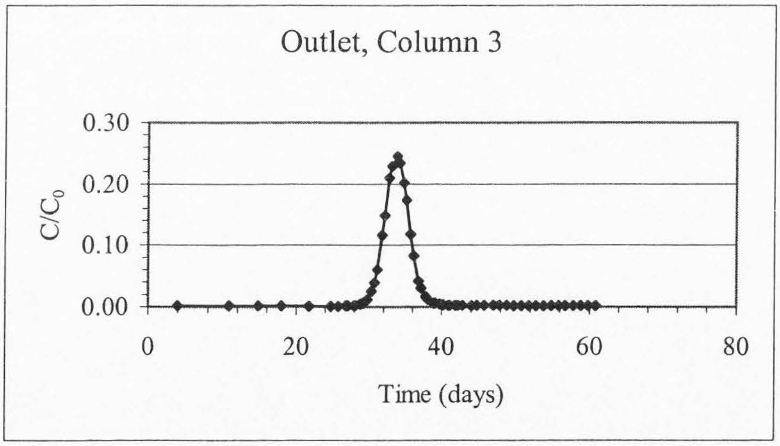
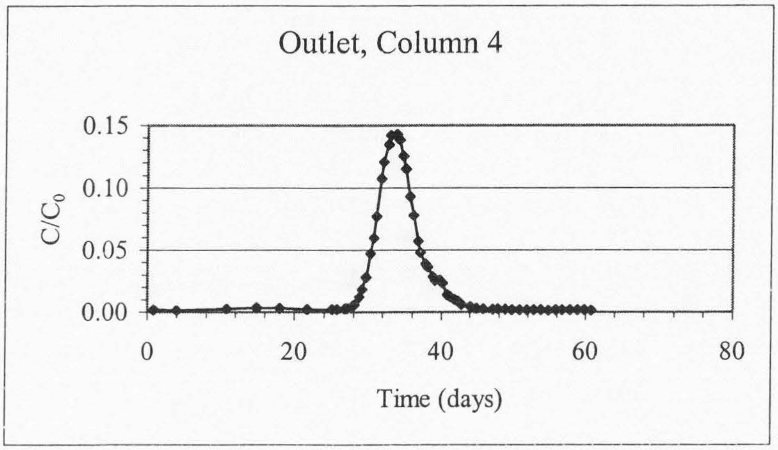


Figure 4-10. Unfitted BTCs for the outlet, May 26. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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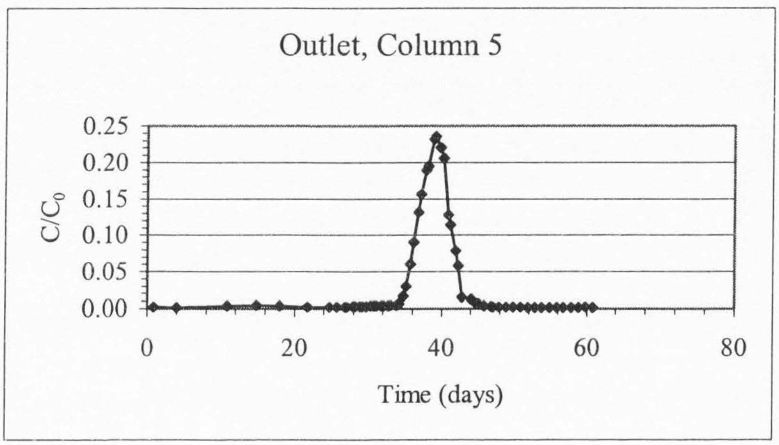

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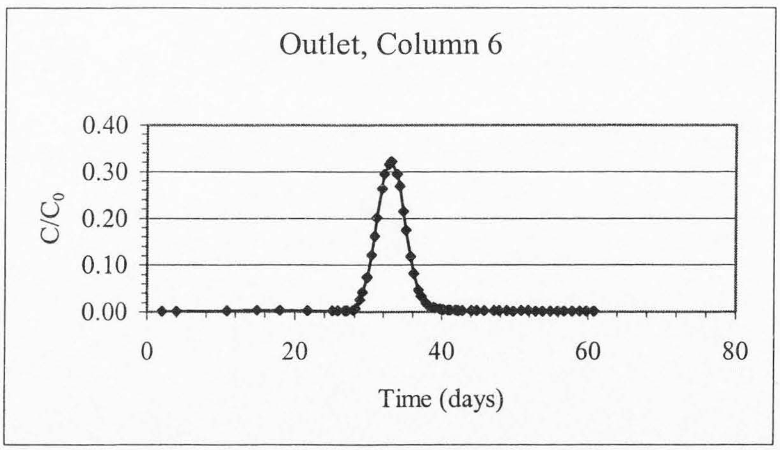

Figure 4-10. (Continued)

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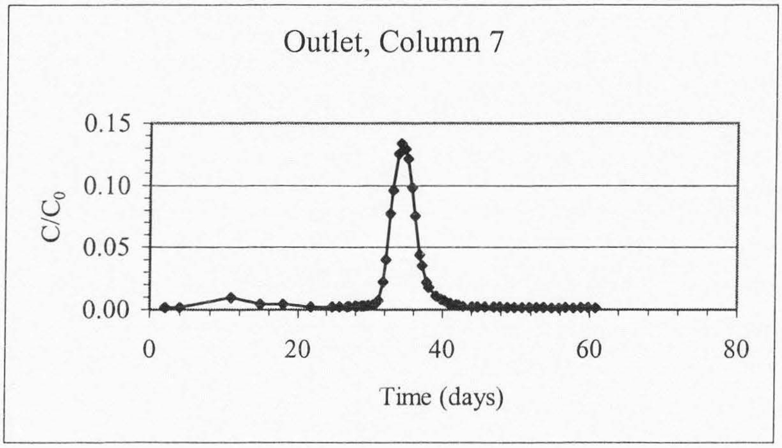

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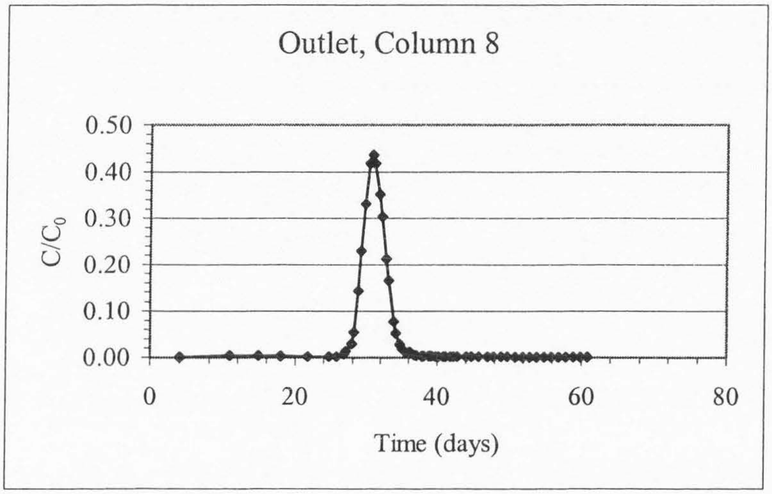

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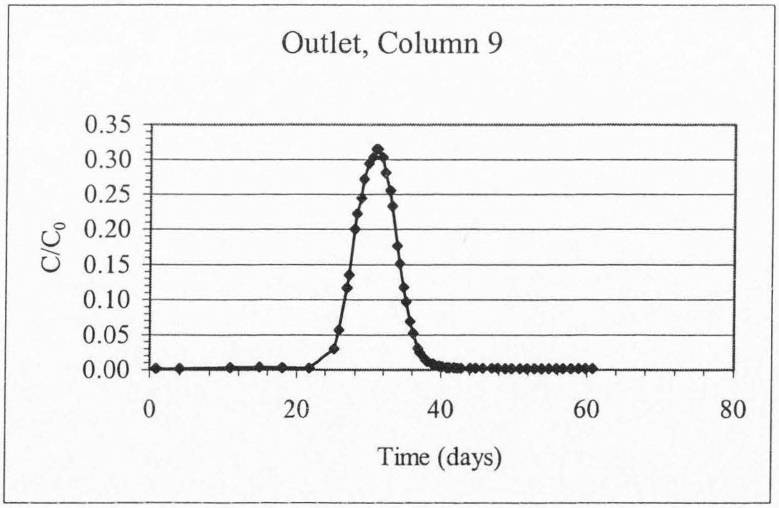


Figure 4-10. (Continued)

passed through this part of each column.

Analysis

A complete listing of the CXTFIT data for Ports A, B, and the outlet can be found in Tables A-9, A-10, and A-11, respectively, in Appendix A.

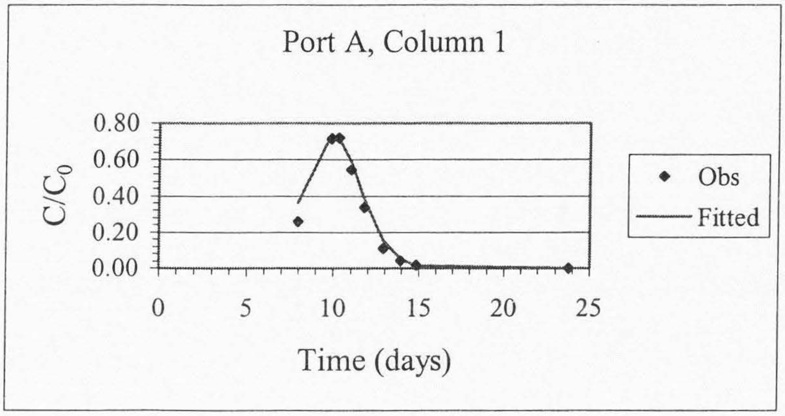
Port A Models

The main form of analysis was to use the CXTFIT program to fit the curves and give more accurate estimates of the velocity and dispersion in the columns. Although the curves for Port A are sparse and missing one or more leg portions, CXTFIT was able to estimate reliable and logical values of velocity and dispersion. Figure 4-11 shows the observed data and the fitted curves. Table 4-7 summarizes the information provided by the Port A models. As evidenced by the r^2 values, the CXTFIT program fit the data curves quite accurately. There are no r^2 values under 0.926. The velocity values are higher than the original estimate of 4.7 cm/day and the dispersion values are lower than the original estimate of 18.3 cm^2/day. The velocity variation is likely due to a difference in porosity from the estimate to the actual conditions in the column. A higher velocity suggests a lower porosity value. The porosity likely has a range of 0.32 to 0.38, calculated by rearranging Equation 3 and solving for porosity using the CXTFIT velocity values. The lower value of dispersion was not expected due to the fine-grained nature of the soil.

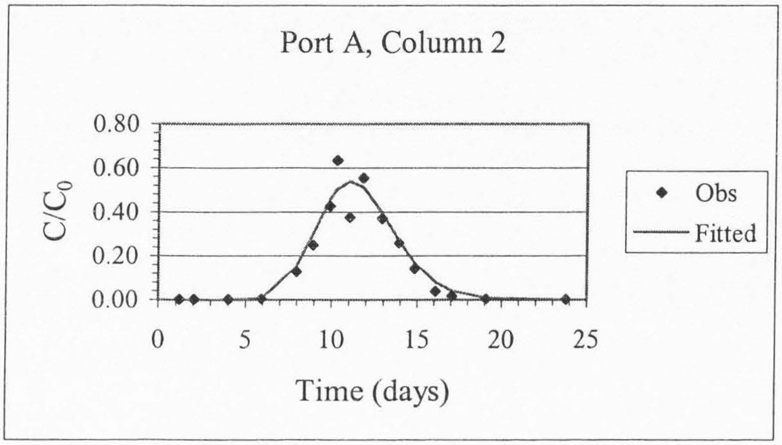
Port B Models

As with the Port A models, the Port B models worked with the incomplete data

A



B



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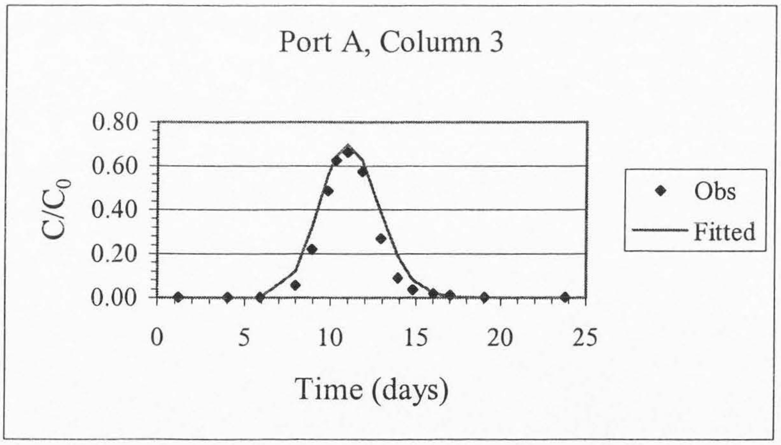
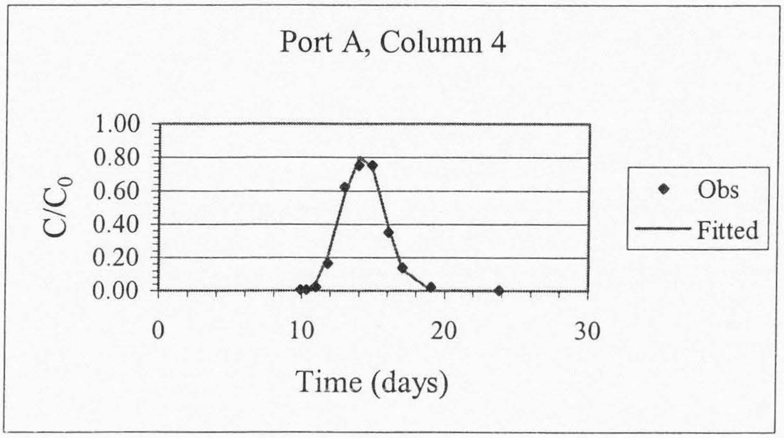


Figure 4-11. Fitted BTCs using CXTFIT for Port A, May 26. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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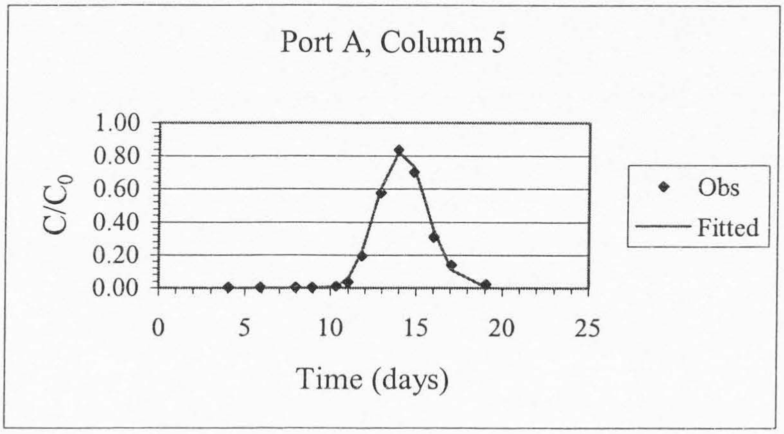

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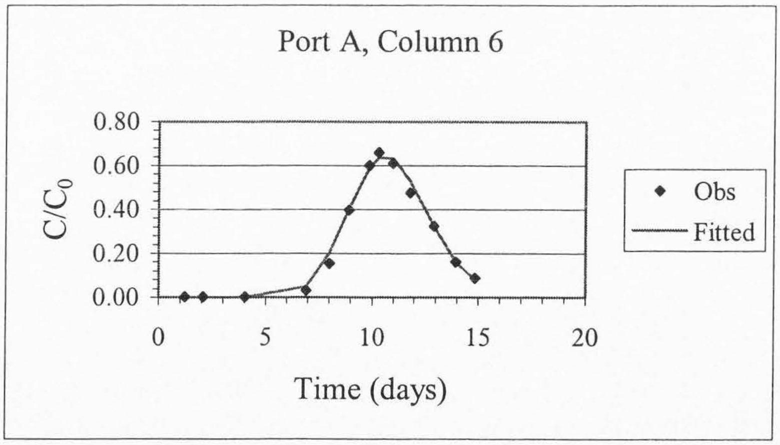
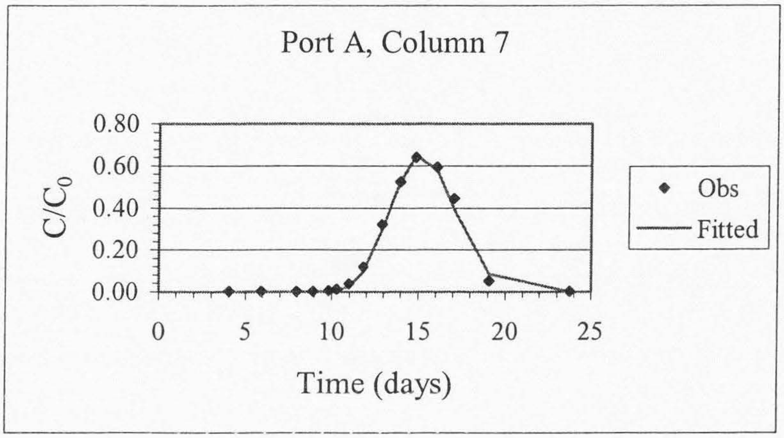


Figure 4-11. (Continued)

G



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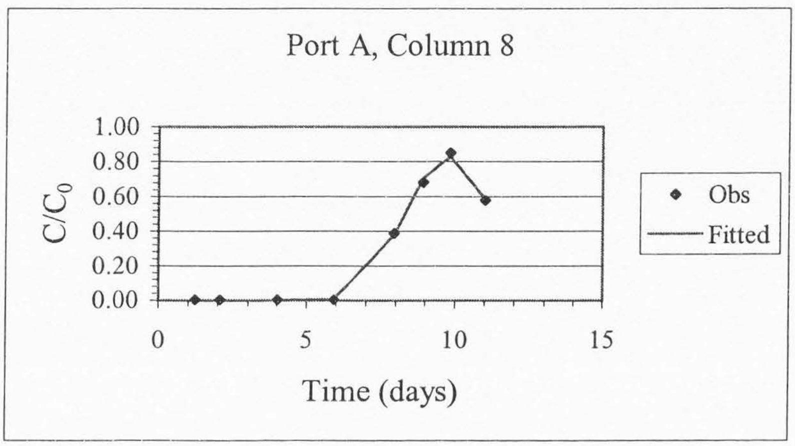

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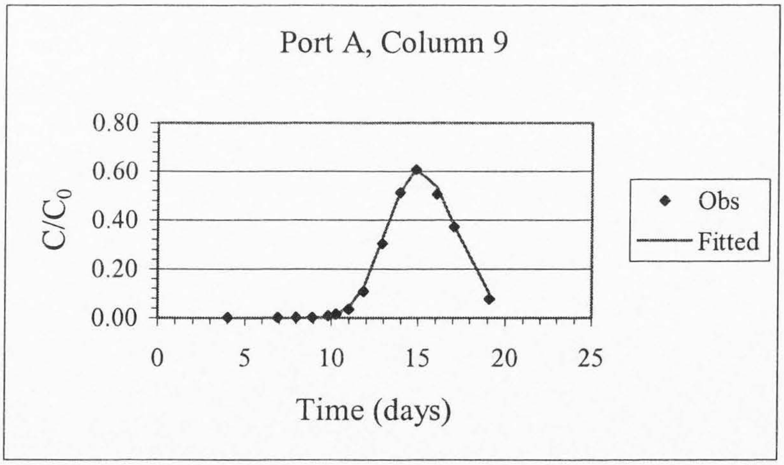


Figure 4-11. (Continued)

Table 4-7. Summary of Port A Model Data, May 26.

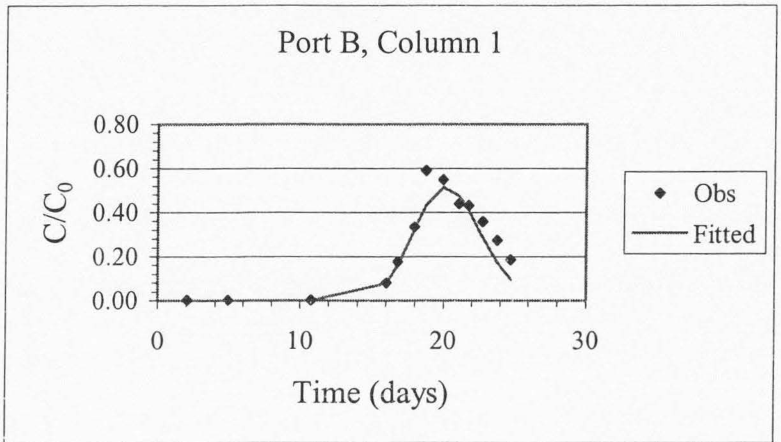
Column Number	1	2	3	4	5	6	7	8	9
Velocity (cm/day)	7.22	6.17	6.37	6.76	6.81	6.57	6.25	7.36	6.28
Dispersion (cm^2/day)	5.60	8.42	4.62	2.32	2.24	6.42	3.64	3.96	4.51
r^2 values	0.975	0.926	0.948	0.991	0.994	0.991	0.993	0.999	0.997

comprising the breakthrough curves. Columns 2, 5, and 7 had no tracer pulse peaks recorded. The pulse reached the Port B location in these columns after sampling had been stopped on June 18 (Columns 2 and 7) and June 19 (Column 5). Graphs of the partial Port B models can be found in Figure 4-12. A summary of the parameters obtained with CXTFIT can be found in Table 4-8. The data began to diverge for Columns 1, 2, 4, and 8, as evidenced by the r^2 values. Columns 5 and 7, which had no pulse peaks, show nearly perfect fits because only partial portions of the approaching leg of the BTC were recorded and modeled, as seen in Figure 4-12.

Outlet Models

During the initial phases of modeling the outlet data, the curves matched well and the r^2 values were near 0.900. However, as more data were collected and the peak passed by, the models diverged significantly from the observed data. Table 4-9 summarizes the CXTFIT outlet model data prior to mass adjustments. Figure 4-13 shows each outlet model with observed data. Column 9 had a moderately accurate fitted curve, but the r^2 values for the other columns continued to show that the fits were not as accurate as

A



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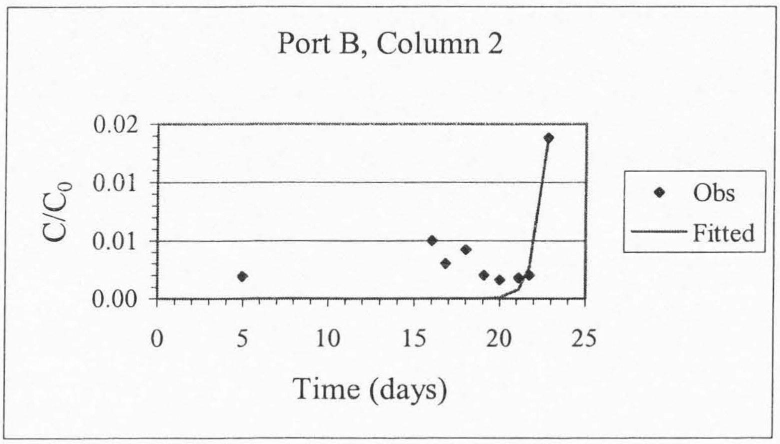

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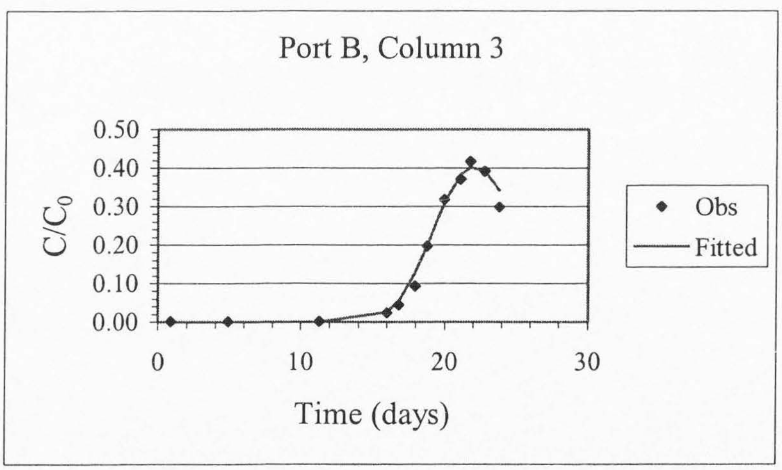
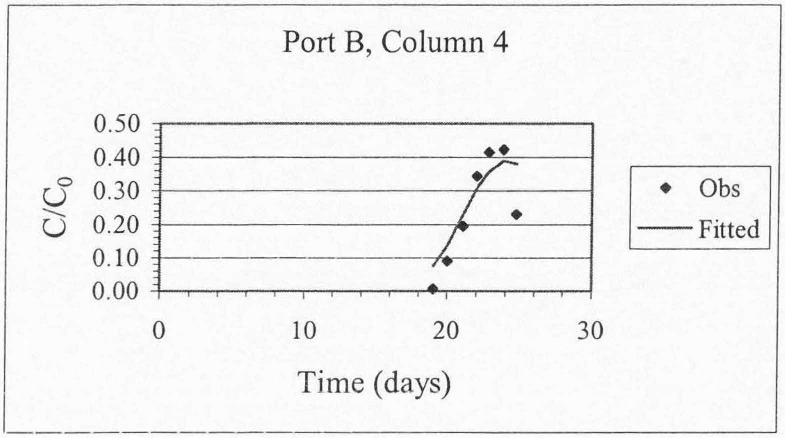


Figure 4-12. Fitted BTCs using CXTFIT2 for Port B, May 26. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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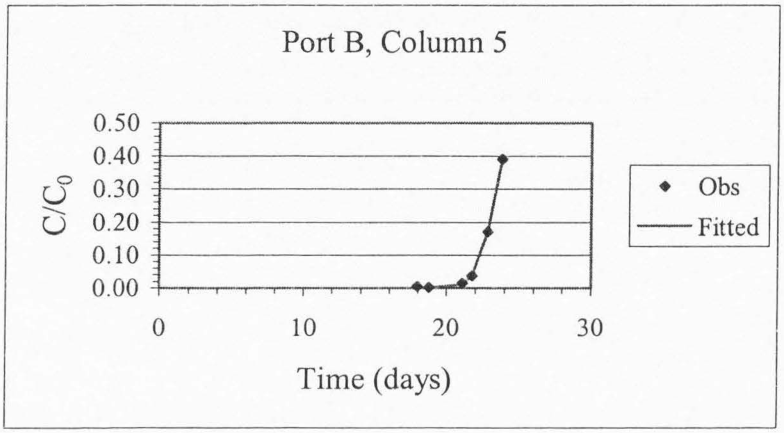

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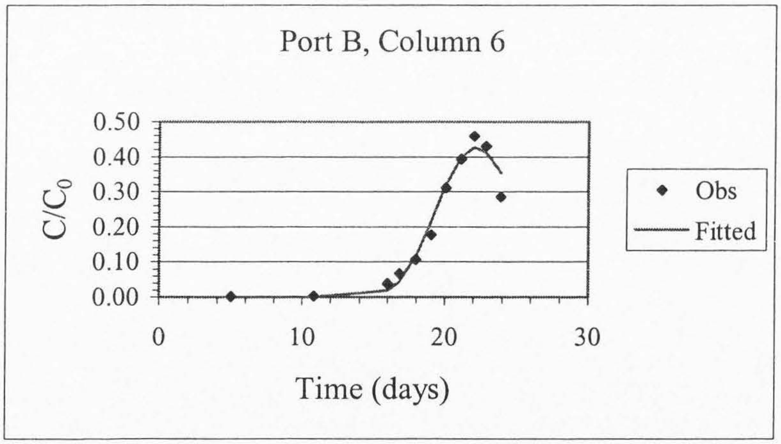

Figure 4-12. (Continued)

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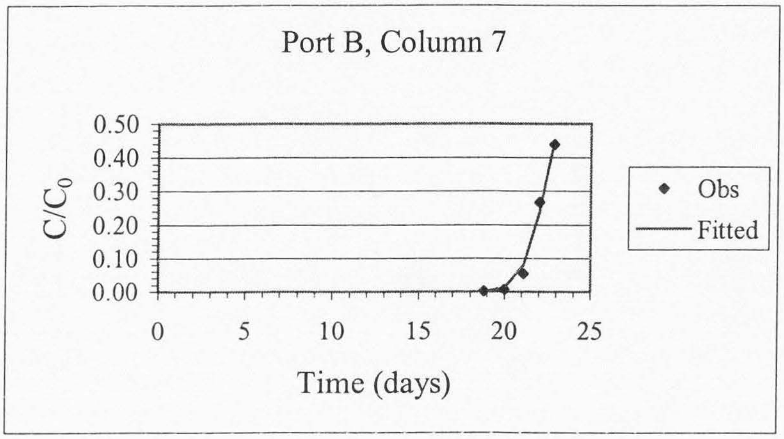

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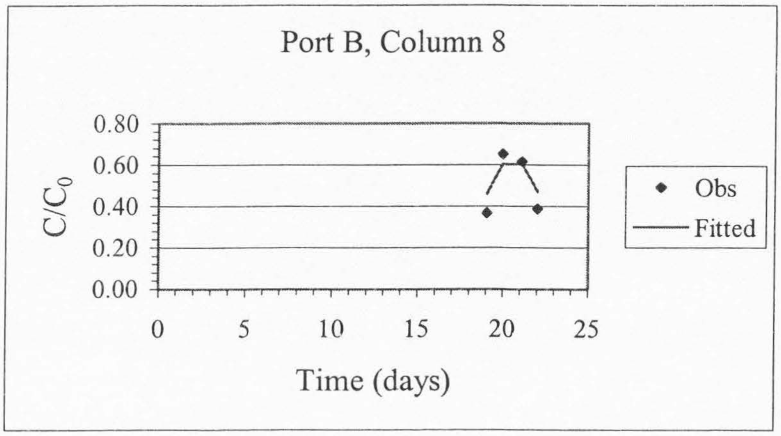

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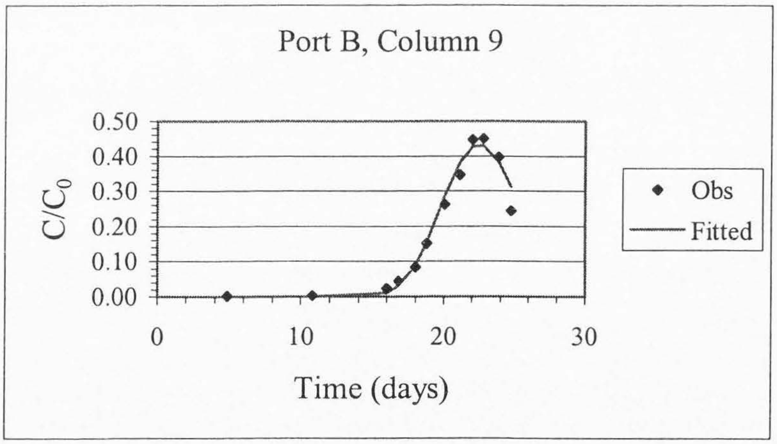


Figure 4-12. (Continued)

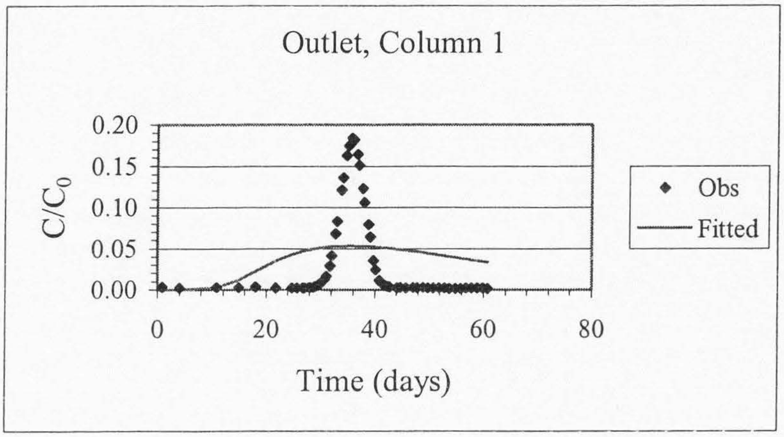
Table 4-8. Summary of Port B Model Data, May 26.

Column Number	1	2	3	4	5	6	7	8	9
Velocity (cm/day)	6.48	4.46	5.84	5.32	5.04	5.84	5.30	6.37	5.75
Dispersion (cm^2/day)	5.20	1.84	6.71	5.49	1.12	5.90	1.22	3.03	5.45
r^2 values	0.898	0.485	0.989	0.764	1.000	0.971	0.988	0.727	0.977

Table 4-9. Summary of Outlet Model Data Prior to C_0 Adjustments, May 26.

Column Number	1	2	3	4	5	6	7	8	9
Velocity (cm/day)	4.19	2.49	4.92	4.24	4.20	6.06	2.76	6.44	6.41
Dispersion (cm^2/day)	148.0	50.0	202.0	270.0	59.9	7.97	405.0	4.66	8.75
r^2 values	0.105	0.214	0.084	0.124	0.114	0.459	0.046	0.581	0.909

A



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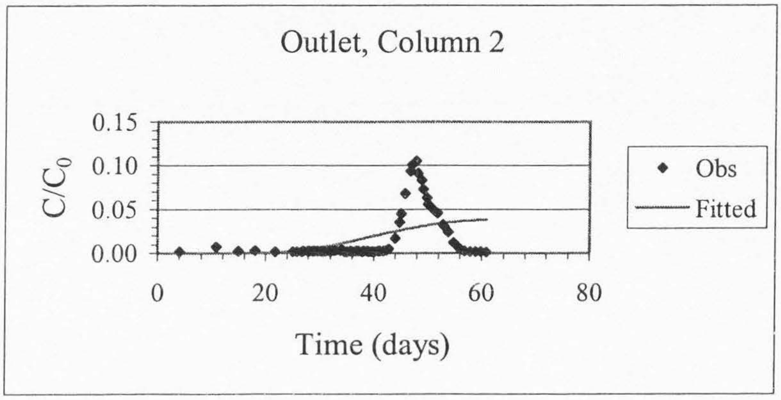

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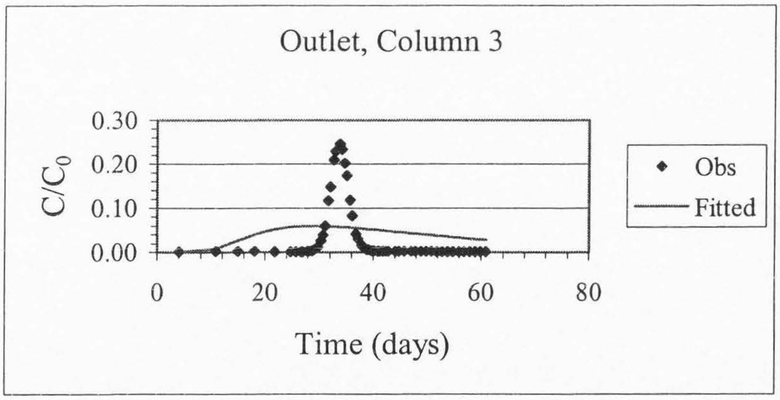
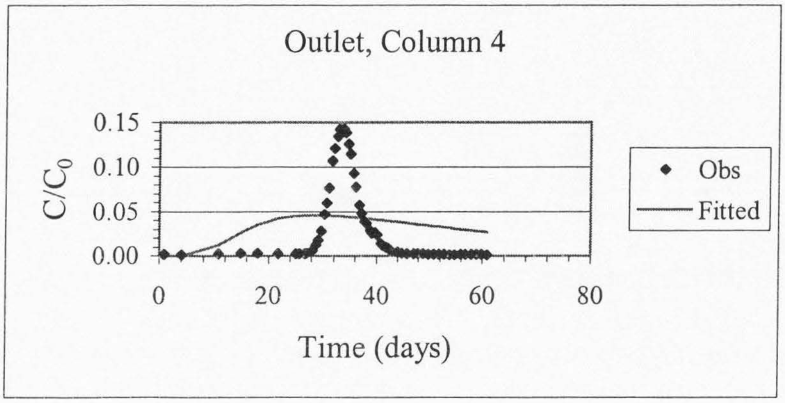


Figure 4-13. Fitted BTCs using CXTFIT for the outlet, May 26, where no adjustment for tracer lost by sampling at Ports A and B has been made. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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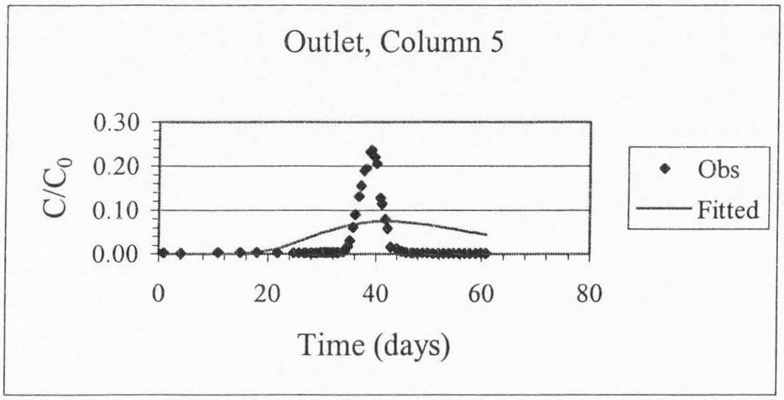

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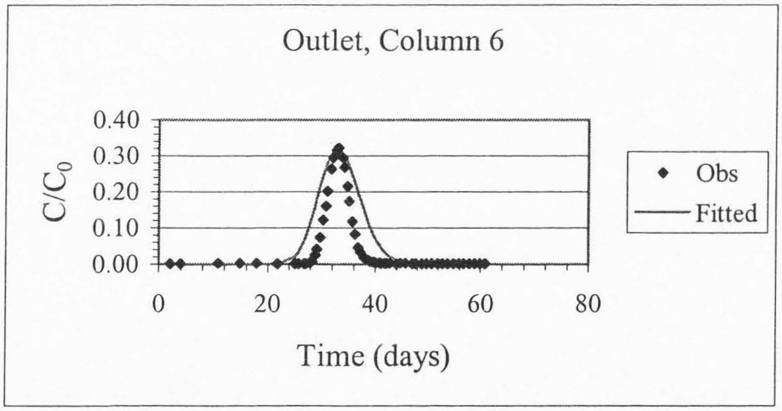

Figure 4-13. (Continued)

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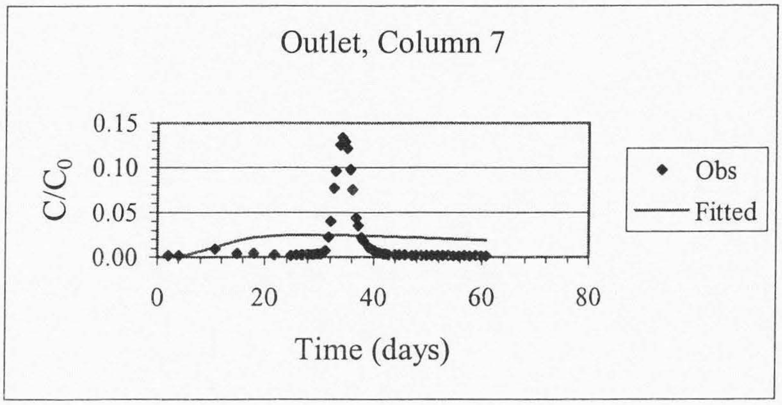

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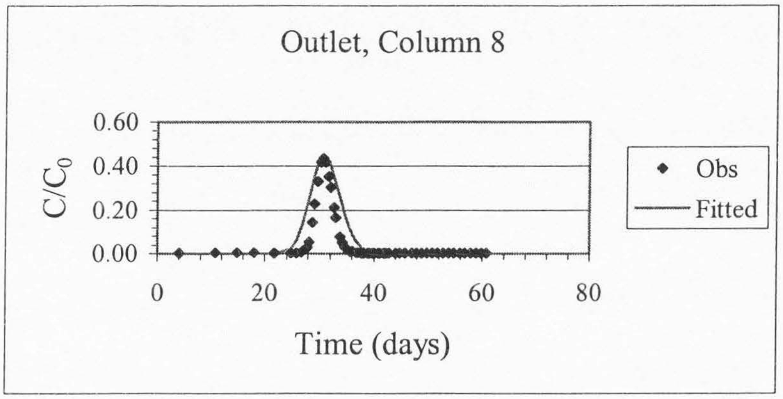

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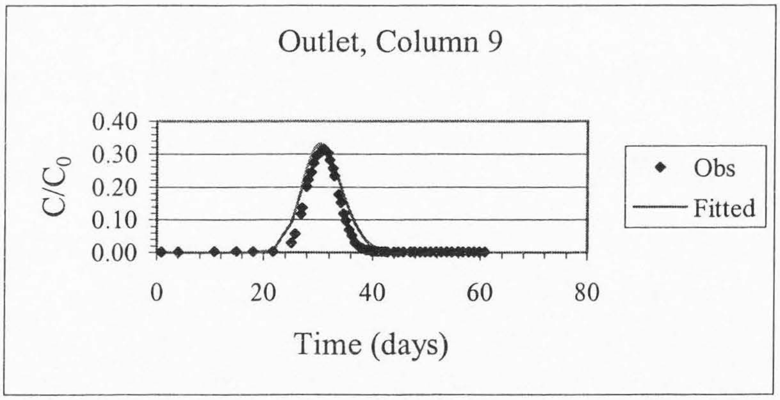


Figure 4-13. (Continued)

possible. Columns 8 and 6 had values of r^2 equaling 0.581 and 0.459, respectively, but the remaining six columns had values under 0.214. These columns (6, 8, and 9) likely diverged less because they had fewer leakage problems in the early stages of the tracer test.

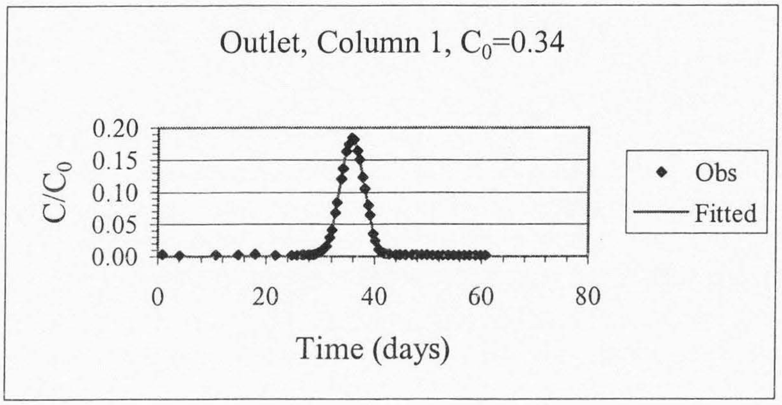
Re-normalized (for tracer lost) Outlet Models

In order to accurately fit the observed data, input parameters in CXTFIT were adjusted according to each column individually. The default value of C/C_0 in the program is 1.0. In other words, the program operates under the assumption that the entire tracer amount put into the column has the opportunity to exit the column and be measured at the outlet location. Because samples were taken at Ports A and B, the tracer available at the outlet was not equal to the tracer put into the columns. The C/C_0 input value was adjusted for each column until the r^2 value was near or above 0.900 signifying an accurate fit of the model data with the observed data. The adjusted BTCs are shown in Figure 4-14. A summary of the CXTFIT outlet model data after concentration adjustments were made is shown in Table 4-10. The CXTFIT data output for all nine columns after C_0 was modified can be found in Table A-12 in Appendix A.

Tracer Lost Estimates

The original volume of tracer put into each column is 1.296 L, calculated by multiplying the pumping rate (0.3 mL/min) by the 3 days of the pulse application. The adjusted C/C_0 fraction used in the CXTFIT models was used to calculate the available concentration of bromide at the outlet. For Column 1, the input concentration of tracer was 522 mg/L and the C/C_0 value that yielded the most favorable r^2 value was 0.34.

A



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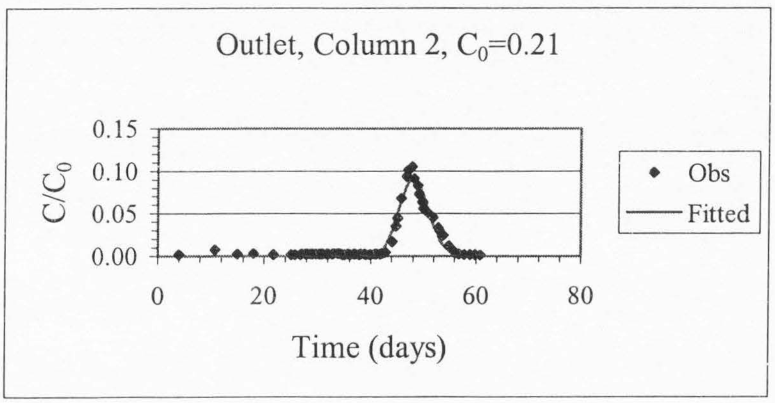

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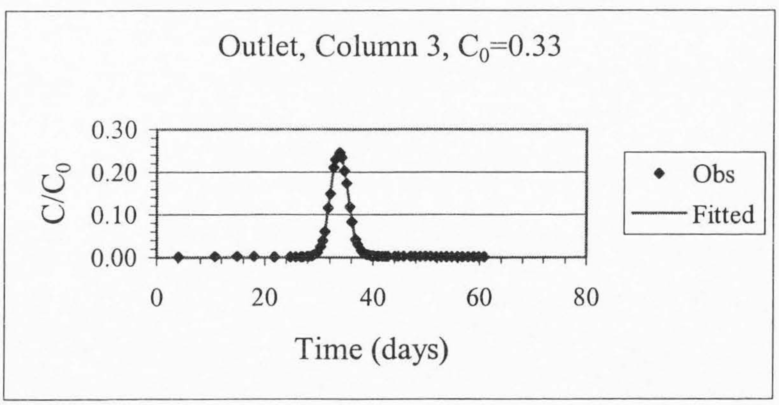
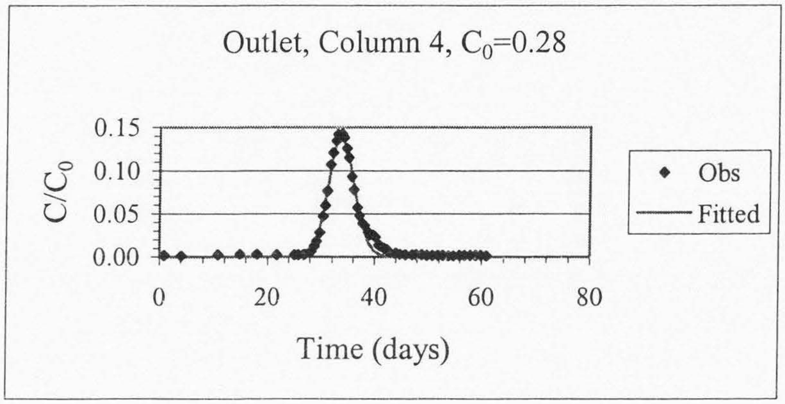


Figure 4-14. Fitted BTCs using CXTFIT for the outlet, May 26, where adjustments for tracer lost by sampling at Ports A and B have been made. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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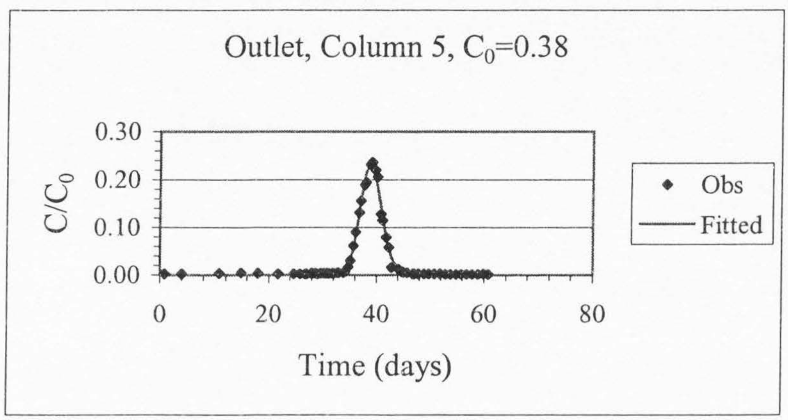

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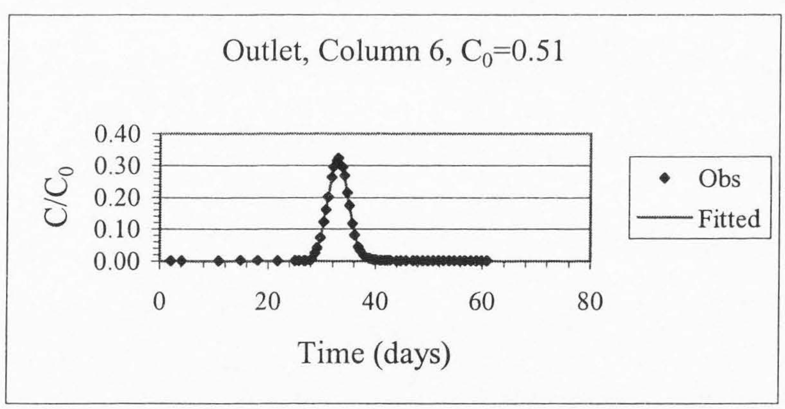

Figure 4-14. (Continued)

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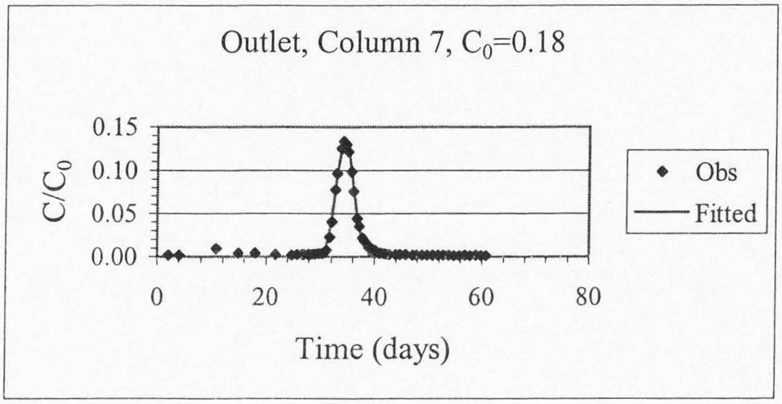

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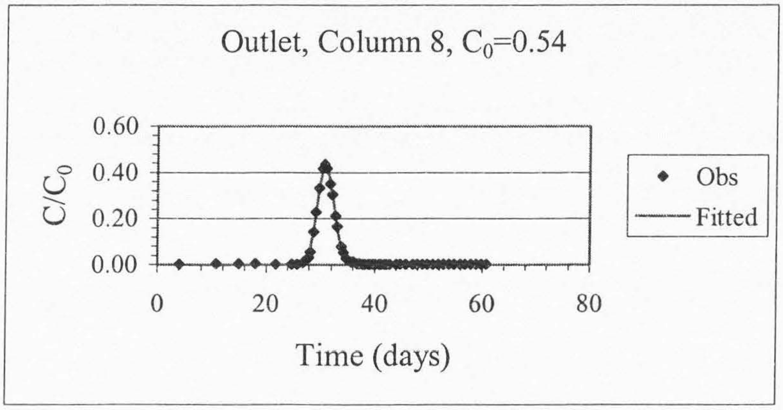

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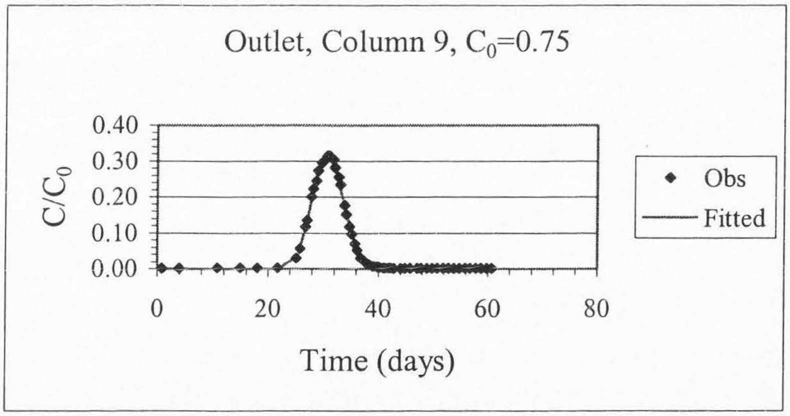

Figure 4-14. (Continued)

Table 4-10. Summary of Outlet Model Data with C_0 Adjustments, May 26.

Column Number	1	2	3	4	5	6	7	8	9
Velocity (cm/day)	5.63	4.12	6.00	5.96	5.19	6.12	5.80	6.47	6.41
Dispersion (cm^2/day)	1.91	1.23	0.99	2.79	1.09	1.68	0.90	1.00	5.03
r^2 values	0.998	0.959	0.999	0.983	0.993	0.999	0.989	0.996	0.998

Multiplying the input concentration by the C/C_0 value gives the adjusted amount of bromide tracer that was available at the outlet location. For Column 1, this value was 177.5 mg/L. A value for tracer mass removed from the column can be estimated using the application volume. Multiplying the difference between the original C_0 value and the adjusted C_0 value by the tracer application volume (1.296 L) gives a value of potential mass of bromide lost from each column. For Column 1 this value was calculated to be 446.5 mg. Dividing this mass value by the original C_0 value gives an estimate of the volume of tracer lost. Using this calculation, Column 1 potentially lost 0.86 L of applied tracer by leakage and sampling at Ports A and B. Table 4-11 summarizes the adjusted C/C_0 values and estimates of the mass and volume lost for each of the nine columns. It is important to note that these values of mass and volume of tracer removed are only estimates. Leakage is especially apparent in Columns 2 and 7 where the C/C_0 values are significantly lower than their neighbors, suggesting that they lost more volume during the course of the tracer test.

A second way the lost amount of tracer was estimated was by quantifying the amount of actual samples taken from Ports A and B. An average total of 26 samples

Table 4-11. Lost Tracer Estimates, May 26.

Column Number	1	2	3	4	5	6	7	8	9
Model C/C_0 Input	0.34	0.21	0.33	0.28	0.38	0.51	0.18	0.54	0.75
Original C_0 (mg/L)	522	525	526	525	540	537	535	546	544
Adjusted C_0 (mg/L)	177.5	110.3	173.6	147.0	205.2	273.9	96.3	294.8	408.0
Potential Mass Lost by Sampling (mg)	446.5	537.5	456.7	489.9	433.9	341.0	568.6	325.6	176.3
Potential Volume Lost by Sampling (L)	0.86	1.02	0.87	0.93	0.80	0.64	1.06	0.60	0.32

were collected from the side ports, as shown in Table 4-12. Multiplying the total number of samples for each column by 20 mL gives an estimate of the total sampling volume removed from the column. This sampling volume includes, but is not equal to, the amount of tracer solution removed from the columns. At any given time, there is approximately 12.7 L of water present in the column (soil volume 0.0353 m^3 multiplied by a porosity estimate of 0.35), 1.296 L of which is tracer solution. The sampling volumes removed from the nine columns are all smaller values than those volumes calculated using the CXTFIT C/C_0 values as shown in Table 4-11 with the exception of Column 9. The smaller sampling volumes (excluding Column 9) indicate that the volume values calculated using the CXTFIT data compensate for volume lost by leakage as well as volume lost by sampling from Ports A and B. Also, CXTFIT assumes that samples have concentrations equal to the input. This second method takes into account the fact that dilute samples were removed from each column during sampling.

Table 4-12. Tracer Lost Estimates Using Number of Samples Taken from Ports A and B, May 26.

Column Number	1	2	3	4	5	6	7	8	9
Port A Samples Taken	12	17	16	16	15	13	17	8	16
Port B Samples Taken	13	9	12	12	11	11	10	9	12
Total Samples Taken from Ports A and B	25	26	28	28	26	24	28	17	28
Total Volume Removed by Sampling (mL)	500	520	560	560	520	480	560	340	560
Mass Br- Removed by Sampling at Port A (mg)	28.67	33.71	32.15	29.95	30.61	37.65	29.67	27.38	27.79
Mass Br- Removed by Sampling at Port B (mg)	35.73	0.37	22.69	18.06	6.83	24.38	8.43	22.26	26.69
Total Mass Br- Removed by Sampling (mg)	64.40	34.08	54.84	48.01	37.44	62.03	38.10	49.64	54.48

The mass of bromide removed was also calculated for each column at Ports A and B. The bromide concentration for each sample was multiplied by a sampling volume of 20 mL to yield a sampling mass in milligrams. These mass values were summed and are shown as the total mass removed by sampling at Ports A and B in Table 4-12. A total of 443.02 mg of bromide was removed from the nine columns during sampling at Ports A and B. This corresponds to an average of 49.22 mg of bromide per column.

As seen in Table 4-11, the potential mass of bromide lost due to sampling (and leakage) is significantly higher than that calculated in Table 4-12 using sampling frequency and volume. The potential mass removed, as calculated by the CXTFIT parameters, had a total value of 3776.0 mg. This corresponds to an average of 419.6 mg per column. Both the total value and the average value per column are 8.5 times higher than those estimated by quantifying the number and concentrations of samples taken from the columns. This shows that the CXTFIT estimations of mass lost by sampling are extremely high and assume that each sample was comprised of concentrated tracer solution only rather than a dilute solution of tracer mixed with the site groundwater also circulating in the columns.

Velocity Comparison (Effluent vs. CXTFIT)

The velocity values given by the effluent measurements and the CXTFIT models vary slightly, but are on the same order of magnitude. The average velocities for the effluent and CXTFIT were 3.62 cm/day and 5.74 cm/day, respectively. Since velocity values did tend to vary column by column, all values are shown in Table 4-13. The variance is most likely due to the calculation methods involved in the two processes. The

Table 4-13. Velocity Comparison Between CXTFIT Values and Calculated Effluent Values, May 26.

Column Number	1	2	3	4	5	6	7	8	9	Avg.
Effluent Velocity (cm/day)	3.85	2.26	4.04	3.84	2.96	3.98	3.95	3.86	3.83	3.62
CXTFIT Velocity (cm/day)	5.63	4.12	6.00	5.96	5.19	6.12	5.80	6.47	6.41	5.74

effluent velocities are dependent on an estimate of porosity in the columns. The CXTFIT velocities are dependent on the closeness of the curve matching of the model curve to the observed data. As discussed in the Port A Models section, the CXTFIT velocities can give a more accurate estimate of the porosity than the original value of 0.50 used in the velocity calculations. Using the highest and lowest velocity values and rearranging Equation 3 to solve for porosity gives a range of values from 0.37 to 0.57. However, it is important to note that these values are dependent on the curve matching based on the adjusted C_0 values in CXTFIT. Another method of estimating porosity that should have been employed prior to the start of this tracer test uses Equation 4:

$$n = 1 - \frac{\rho_b}{\rho_0} \qquad (4)$$

where n is porosity, ρ_b is bulk density equal to 1.6 kg/m^3, and ρ_0 is particle density equal to approximately 2.5 kg/m^3. This gives a porosity value of 0.36 and is a more accurate estimate than 0.50 to use in later calculations.

Comparison to Predictive Models

To determine the effectiveness and accuracy of the predictive models, the predictive model data were compared with the observed data models after mass adjustments had been made. As seen in Table 4-6, the average time for the peak concentration to reach the outlet was 35.47 days, and the average peak concentration was 0.24. When modeled, the outlet had an average dispersion of 1.85 cm^2/day and a velocity of 5.74 cm/day based on the individual values shown in Table 4-10. These data correspond closely with the fifth listed predictive model shown in Table 4-1. This model used a dispersion of 1.83 cm^2/day and a velocity of 5.9 cm/day to yield a peak on Day 32 with a relative concentration value of 0.58. Although the relative concentrations differ, the other three parameter values are very close in magnitude. The discrepancy in relative concentration values can be related back to the problems encountered with the tracer lost during sampling from Ports A and B.

Discussion

Hydraulic Conductivity

Since the daily average K values excluding the negative values more accurately represent steady-state conditions in the columns, they were used for comparison and soil property determination purposes. As shown in Table 4-2, the average daily K excluding the negatives closely corresponds with the K values calculated using the average tensimeter value. Thus it can be concluded that either method of calculating hydraulic conductivity (bulk average or daily average) is suitable and yields a reliable value for this important hydraulic parameter.

Column 7 has an inconsistently high K value among the nine columns. The other eight columns have an average hydraulic conductivity value on the same order of magnitude, while Column 7 had a value one order of magnitude higher than the others (see Table 4-2). The other eight values are between 10^1 cm/day and 10^2 cm/day, suggesting that the soil can be classified as a silty sand to fine sand. One possible explanation for the non-conforming hydraulic conductivity value in Column 7 is because the drip point for the effluent is about 2 cm above the level of the other eight drip points. This is simply due to the nature of the structure that supports the columns. In addition, the tensimeter measurements for Column 7 were lower than the other columns. These two factors caused the difference in head value in the calculation to be a larger number, resulting in a larger hydraulic conductivity value.

Velocity

The velocities measured by effluent flow for the nine columns were relatively consistent, with values between 2.26 cm/day and 4.04 cm/day, as shown in the second line of velocity data in Table 4-3. The fine-grained nature of the soil is the source for some of the differences in velocity and other parameters in the columns. Column 2 has the lowest velocity, 2.26 cm/day. This lower value was likely due to a larger amount of water escaping the column by leakage rather than by effluent flow, and by a late-noticed blockage in the effluent tubing. After this blockage was removed (during the last week of sampling), the daily calculated effluent flows were similar to those of the other eight columns, as shown in Table A-4.

Bromide Concentration

There were two main difficulties encountered during this bromide tracer test. The first was finding a suitable sampling method. Several of the methods, including to a minor extent the one chosen, tended to pull soil out of the sampling ports as well as water, creating a "hole" near the port inside the column. This resulted in the formation of cracks within the soil and a tendency to clog the port to the point that water could no longer be pulled out for analysis. The cracks in the soil present a potential problem in the form of macropores and higher velocity channels for the water to move through. The soil clogging the ports became such a problem that the ports had to be removed temporarily from their insertion point in the column to be thoroughly cleaned. Upon re-inserting the columns, it is inevitable that the end of the port ended up in a slightly different position and the soil near the port had a chance to change position.

The second major problem that was dealt with during this first tracer test was leakage of water from the connection points of the ports with the columns. The o-rings placed between the glass port and glass column did not effectively seal the port in several cases. Several substances were put around the interface, including parafilm, which seemed to work on the minor leaks. During sampling of the outlet, ports that were still leaking were removed and replaced with rubber stoppers. This served as a semi-permanent solution and effectively sealed the leaky ports.

Overall, the results of the outlet bromide analysis were considered unreliable and did not accurately reflect the hydraulic conditions in the columns because of the problems with the tracer lost by leakage and during sampling at Ports A and B. CXTFIT was able to accurately fit the observed data curves, but only after adjusting the input concentration values in the program. It was decided that another bromide tracer test could be run before any TCE dechlorination experiments would start. A few changes were suggested to improve the second bromide tracer test. The velocity was made to be three times higher, thus shortening the length of time for the tracer test from 9 weeks to 3 weeks. The pulse was applied for only 1 day to compensate for the higher velocity. Finally, samples were taken from the outlet exclusively to eliminate the need to compensate for tracer lost during analysis and modeling.

CHAPTER 5

SECOND BROMIDE TRACER TEST

Methods

Creation and Application of Solution

The bromide tracer solution was made by mixing 22 L of nitrogen-sparged site groundwater with 14.165 g of crystalline sodium bromide (NaBr). This resulted in a bromide solution with an average concentration of 538 mg/L and an electrical conductivity (EC) of 1750 μS/cm.

This secondary bromide tracer test began on August 1. The methods used to apply the bromide tracer solution are identical to those described for the May 26 bromide tracer test. The bromide tracer solution fed the columns for a period of 1 day at a rate of 0.665 mL/min. On August 2, the source reservoir and column caps were switched back to the site groundwater to complete the 1-day pulse. The exact times of the application and removal of the tracer pulse for each of the nine columns can be found in Table B-1 in Appendix B.

Sampling

During this bromide tracer test, samples were removed from the outlet only. This exclusion of the upper ports served to preserve the mass available for analysis at the outlet. Outlet samples were collected as described for the May 26 bromide tracer test.

Analytical Methods

The analytical methods used for this bromide tracer test were the same as described for the May 26 test. Each 20 mL sample was analyzed for electrical conductivity and bromide concentration.

Modeling with CXTFIT

As with the data from the May 26 bromide tracer test, the CXTFIT program was selected for the purpose of modeling the bromide tracer breakthrough curves (BTCs). The direct problem method provided predictive models and the indirect problem method was used to fit the observed data at the outlet.

Before applying the pulse, a predictive model was created to estimate the retention time for the outlet location. Velocity was estimated to be 15 cm/day using Equation 3 with the circulation rate at a value of 0.665 mL/min (957.6 cm^3/day), the cross-sectional area of the column (182.4 cm^2), and an estimate of soil porosity (0.35). Dispersion was given a starting point of 1.83 cm^2/day, an average value obtained in the May 26 modeling. The initial velocity and dispersion estimates entered in the program for the indirect problem method were 15 cm/day and 1.83 cm^2/day, respectively.

Predictive Modeling

Using the same velocity and dispersion parameters as in the indirect problem, the CXTFIT model predicted that the pulse was expected to have an extent of approximately 8 days and that the peak would pass the outlet location 13 days after the pulse was applied to the columns. Figure 5-1 is a graph illustrating the output from this predictive model. The highest relative concentration value obtained in this model is 0.27. Because

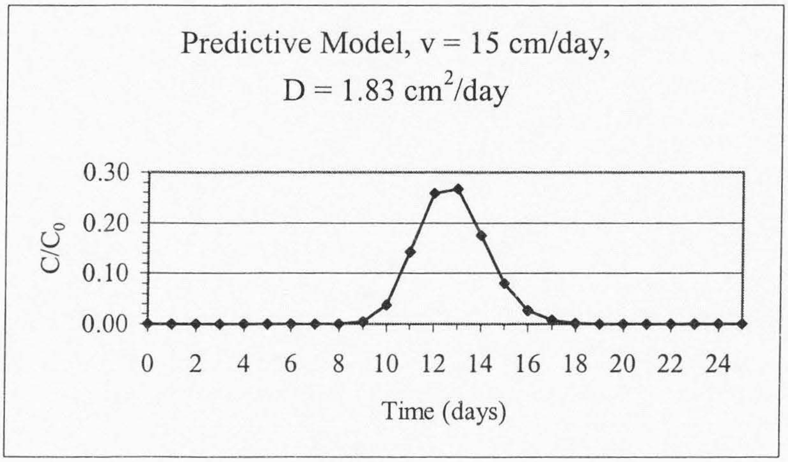

Figure 5-1. CXTFIT predictive model using v = 15 cm/day (n = 0.35) and D = 1.83 cm^2/day, August 1.

there were so many possibilities for error during the May 26 tracer test due to poor porosity estimates and leakage, two predictive models were necessary to accurately estimate retention time and pulse duration for the August 1 tracer test. The second predictive model used the same velocity but an order of magnitude larger dispersion, with a value of 18.3 cm^2/day. This model is shown in Figure 5-2. The retention time was 13 days. The pulse had a spread of 9 days and the highest relative concentration was 0.27.

Hydraulic Parameter Data

Hydraulic Conductivity

As in the May 26 bromide tracer test, the head values at the inlet to the columns were measured using the tensimeter. Since operation of the columns continued between the end of the May 26 test and the beginning of the August 1 test, all columns reached a steady- state condition with the new, higher velocity prior to application of the bromide tracer. The first measurements on August 1 revealed that every column had a constant,

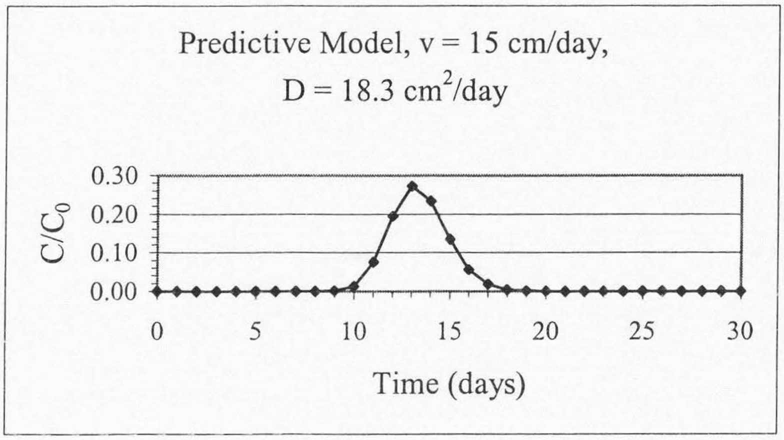

Figure 5-2. CXTFIT predictive model using v = 15 cm/day (n = 0.35) and D = 18.3 cm^2/day, August 1.

positive head value and the hydraulic conductivity of the soil could be calculated. Table 5-1 summarizes the averages and variable input parameters associated with the hydraulic conductivity values, which were calculated using Equation 1. Two hydraulic conductivity (K) values are given in Table 5-1. The first shows values calculated using the average tensimeter reading over the entire length of the tracer test. The second shows an average of the K values calculated on a daily basis. The daily K averages are a more accurate representation of the hydraulic conductivity in the columns because they are not based on a bulk average and take into account minor fluctuations in tensimeter measurements during the tracer test. The complete data sets for the tensimeter measurements and the hydraulic conductivity calculations are given in Appendix B as Tables B-2 and B-3.

Velocity

As with the hydraulic conductivity, steady-state conditions allowed for accurate velocities to be calculated during the entire August 1 bromide tracer test. Table 5-2

Table 5-1. Summary of Averages and Variable Input Parameters Associated with the Hydraulic Conductivity Values, August 1.

Column Number	1	2	3	4	5	6	7	8	9
Average Tensimeter Value (cm H_2O)	72.95	65.33	157.57	53.10	58.90	54.33	41.38	68.62	75.62
Height of Effluent Tubing (cm)	18.5	15.5	19.5	19.0	17.5	19.0	21.5	19.0	17.5
Soil Length (cm)	193.6	192.1	193.5	192.2	194.2	192.8	191.2	190.4	187.9
K Using Average Tensimeter Value Given Above (cm/day)	18.66	20.24	7.36	29.59	24.62	28.65	50.49	20.14	16.97
Average of Daily Calculated K Values (cm/day)	19.12	20.39	7.41	30.05	28.61	29.12	52.45	22.03	17.35

Table 5-2. Average Velocity Measured by Effluent Flow from August 1-23.

Column Number	1	2	3	4	5	6	7	8	9
Total Weight (kg)	18.81	17.96	18.39	19.02	15.43	18.19	18.01	18.21	18.07
Total Time (day)	21.74	21.74	21.74	21.74	21.74	21.74	21.74	21.74	21.74
v Using Total Weights and Times (cm/day)	13.55	12.94	13.25	13.71	11.12	13.10	12.98	13.12	13.02
Average of Daily Calculated v Values (cm/day)	13.79	13.11	13.65	13.96	11.18	13.23	13.52	13.11	13.12

shows the input parameters and the average velocities calculated using Equation 2 for each column for the August 1 tracer test. As with the hydraulic conductivity, two sets of velocity data are given in Table 5-2. The first shows velocities calculated with the bulk sums of water weights and time. The second shows an average of the velocity values calculated on a daily basis during the tracer test. Again, the daily averages are more accurate representations of the true velocities in the columns, and are used later in comparison to the CXTFIT model calculated velocities. Tables B-4 and B-5 in Appendix B give the complete data sets for effluent weights and daily calculated velocities.

Bromide Concentration Data

A complete listing of the data compiled during the August 1 bromide tracer test can be found in Appendix B as Table B-6. The data summarized here are in the form of the observed data BTCs at the outlet for each column.

The only location sampled during this tracer test was the outlet at the bottom of the columns. Thirty-five samples were taken from each of the nine columns to produce the complete breakthrough curves. The BTCs clearly show the movement of the bromide tracer as it passed through the outlet. Figure 5-3 shows all nine outlet BTCs on one plot of relative concentration versus time. Figure 5-4 shows the individual curves in more detail by themselves. Table 5-3 summarizes information about the BTCs for the outlet, including peak day and peak relative concentration.

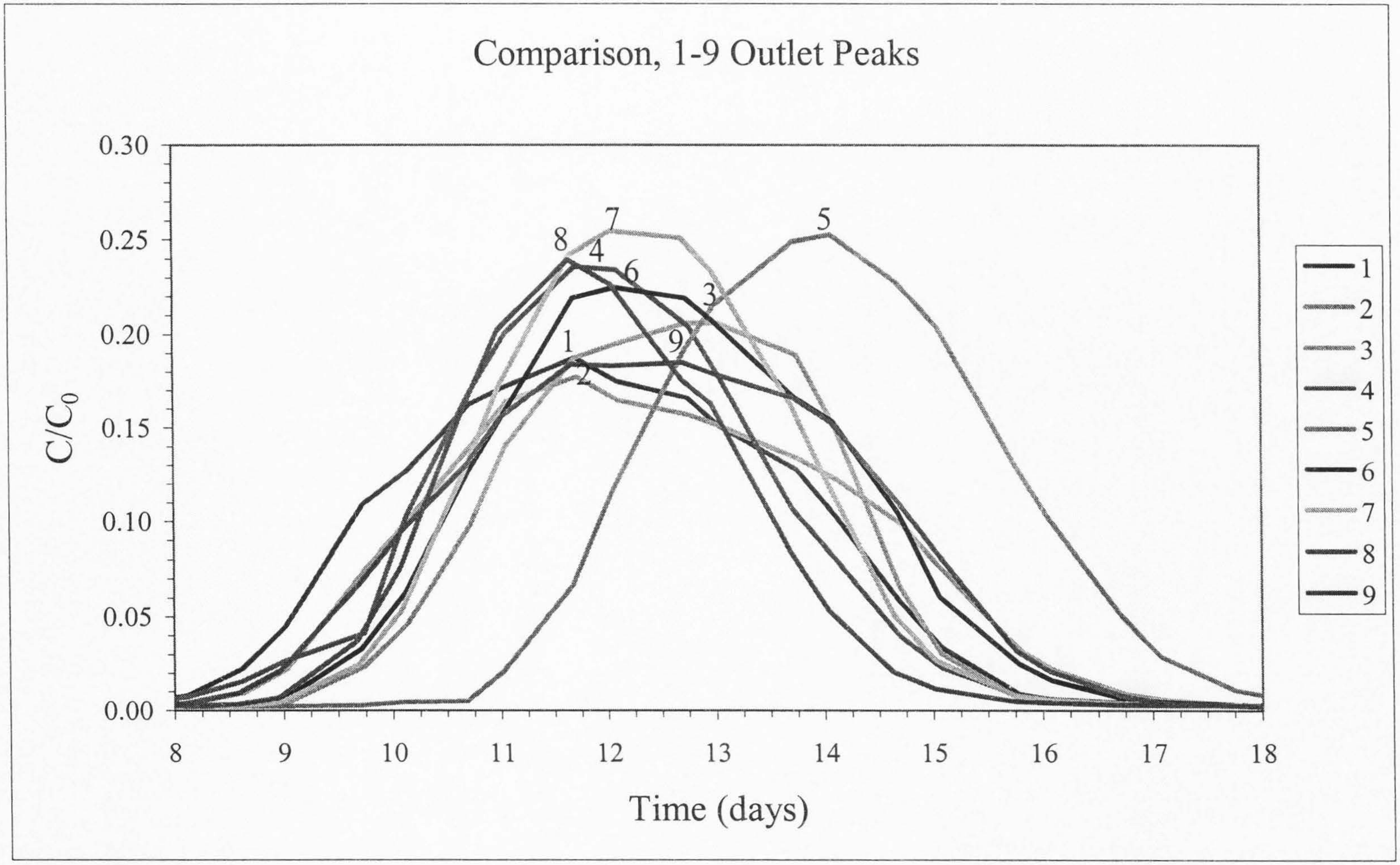

Figure 5-3. Unfitted BTCs for all nine columns at the outlet location, August 1.

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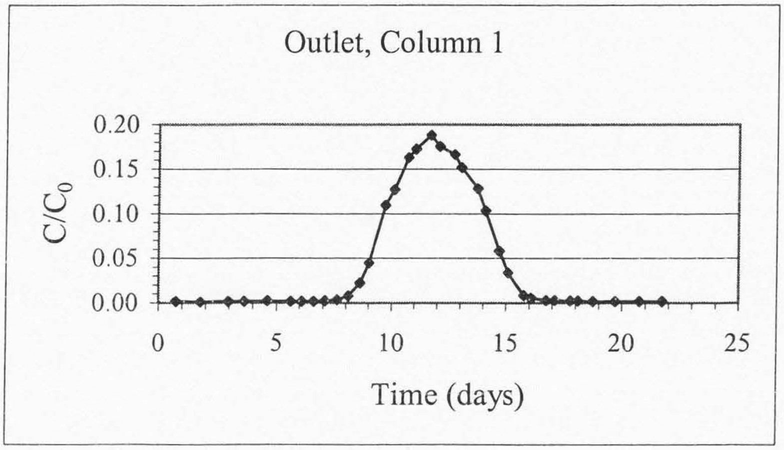

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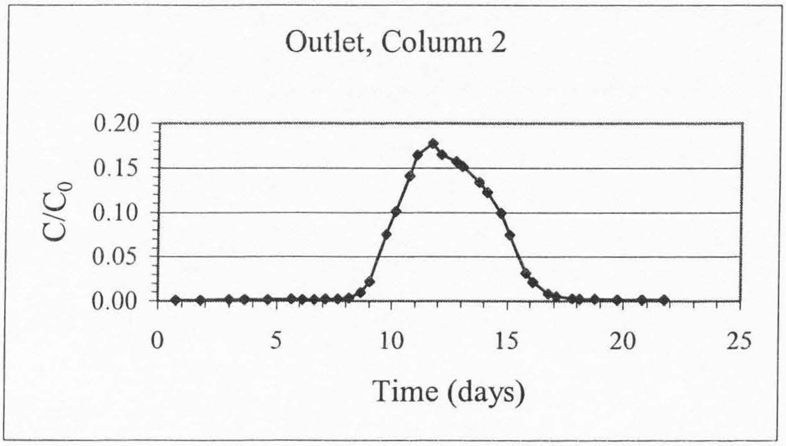

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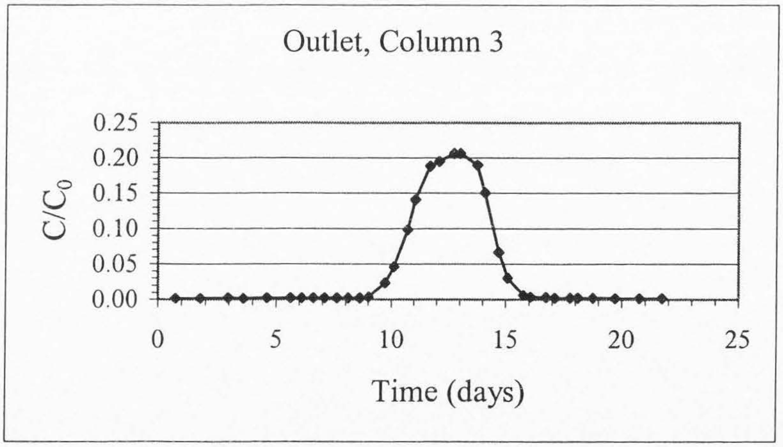

Figure 5-4. Unfitted BTCs for the outlet, August 1. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

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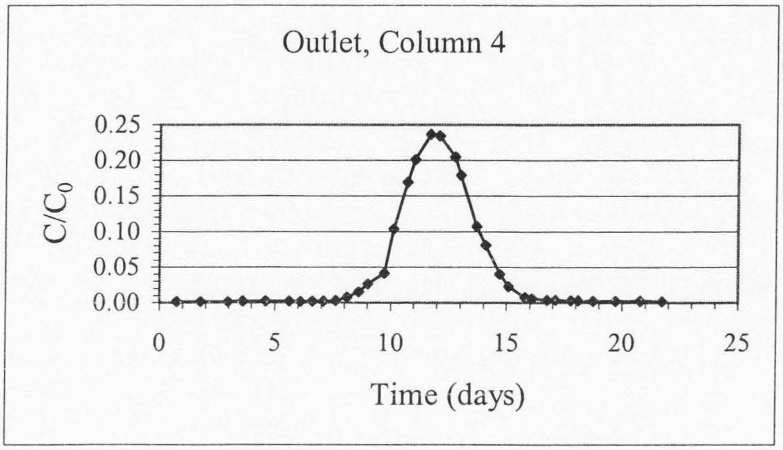

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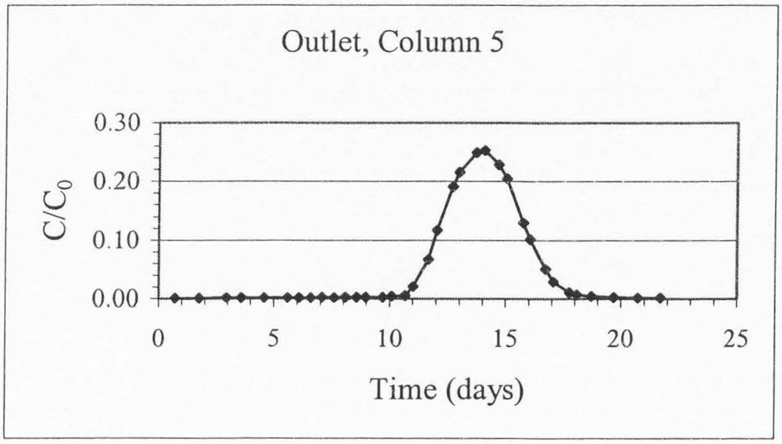

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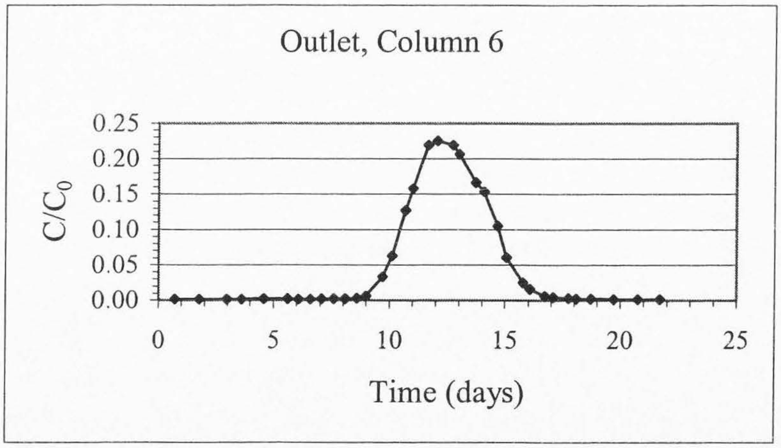

Figure 5-4. (Continued)

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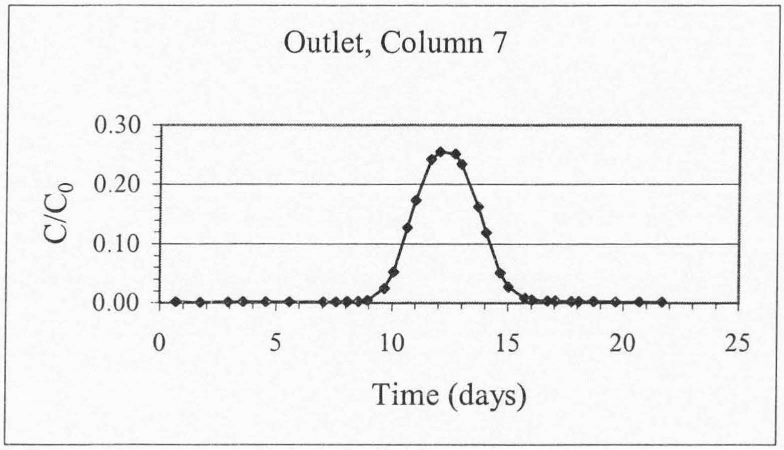

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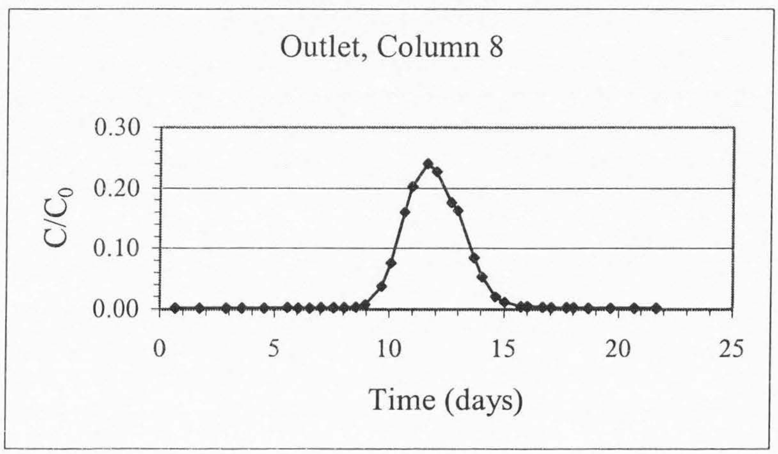

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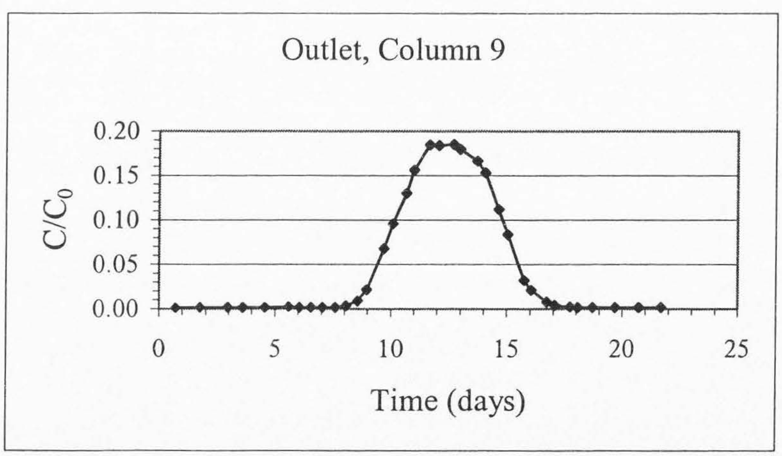


Figure 5-4. (Continued)

Table 5-3. Summary of the Outlet Data Pertaining to BTCs, August 1.

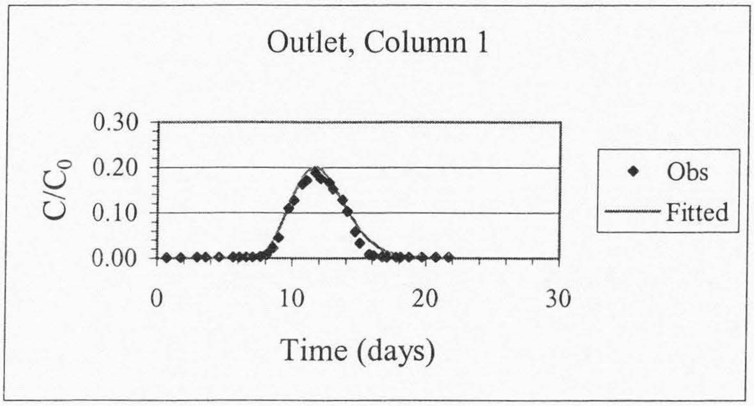
Column Number	1	2	3	4	5	6	7	8	9	Avg.
Peak Day	11.70	11.72	12.88	11.70	14.07	12.07	12.03	11.64	12.70	12.28
Peak C/C_0	0.19	0.18	0.21	0.24	0.25	0.22	0.25	0.24	0.19	0.22

Analysis

CXTFIT Models

CXTFIT was able to estimate reliable and logical values of velocity and dispersion based on the observed data. A complete listing of the CXTFIT data for each of the nine columns can be found in Table B-7 in Appendix B. Figure 5-5 shows the observed data and the fitted curves. Table 5-4 summarizes the information provided by the outlet models. As evidenced by the high r^2 values, the CXTFIT program fit the data curves quite accurately. Although the velocity values are very near the original estimate of 15 cm/day, the dispersion values are about 10 to 30 times higher than the original estimate of 1.83 cm^2/day and up to nearly three times as high as the 18.3 cm^2/day dispersion estimate from the second predictive model. The similarity in velocity values is likely due to the more accurate porosity estimate for the columns than that used in the May 26 analysis. A higher value of dispersion was expected due to its dependence on velocity and pulse length. Since both the velocity and the pulse duration of the May 26 test were approximately one-third smaller than those used during this test, it was expected that the dispersion should mirror that relationship and have a value of approximately three times larger than those calculated in the CXTFIT models of the May 26 data.

A



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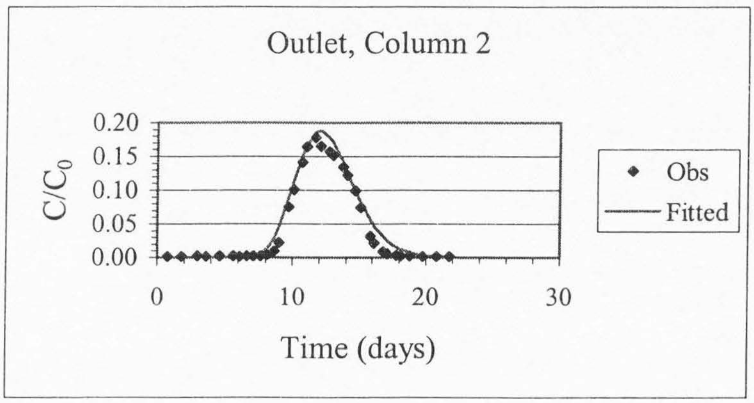

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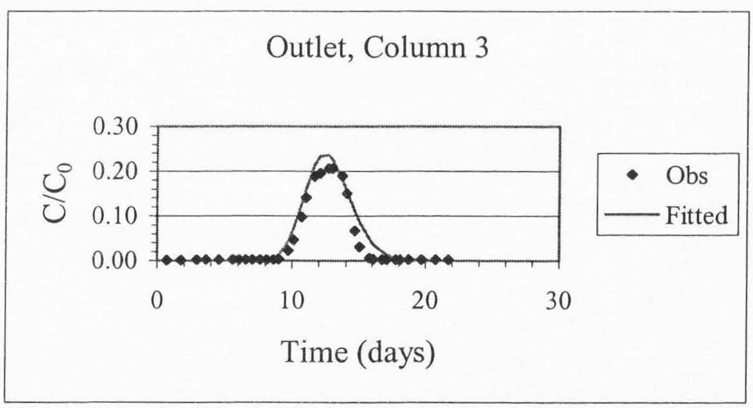

Figure 5-5. Fitted BTCs using CXTFIT for the outlet, August 1. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

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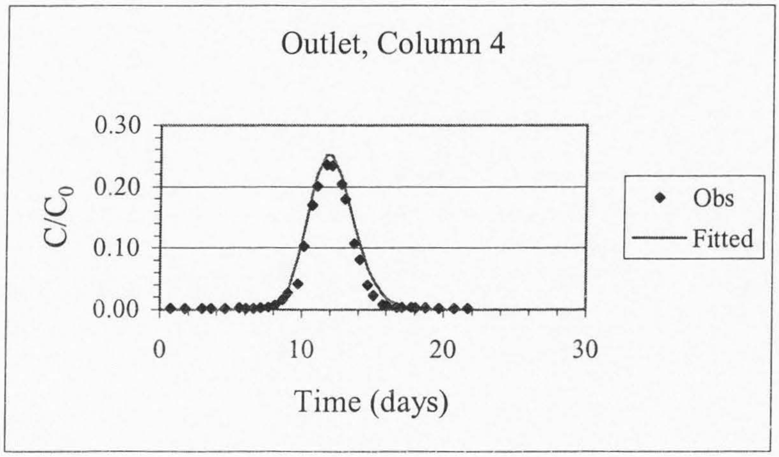

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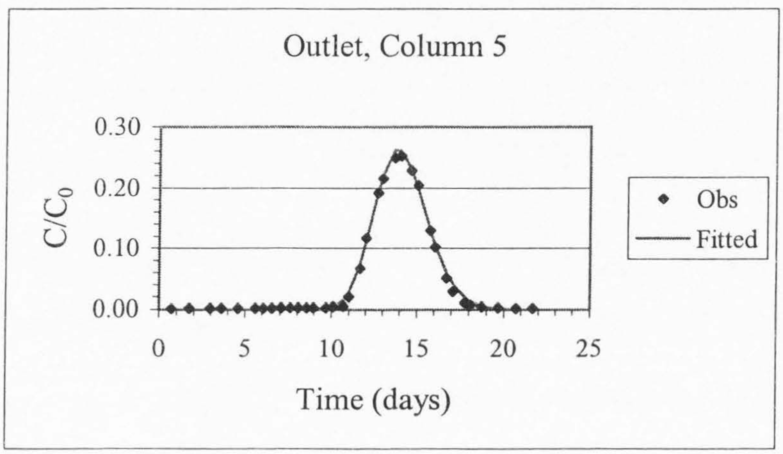

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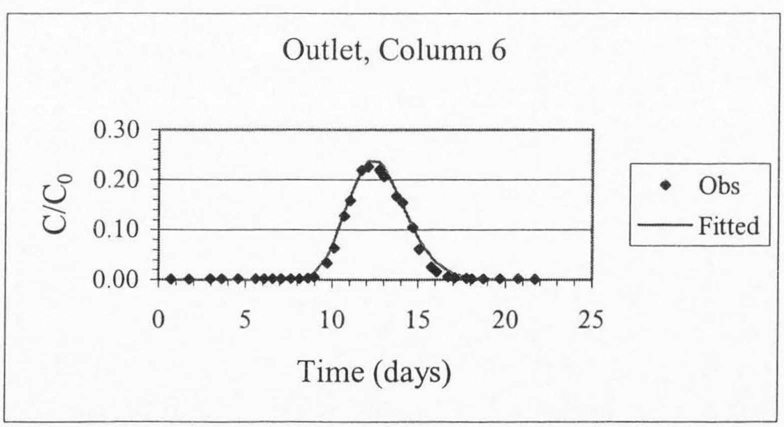

Figure 5-5. (Continued)

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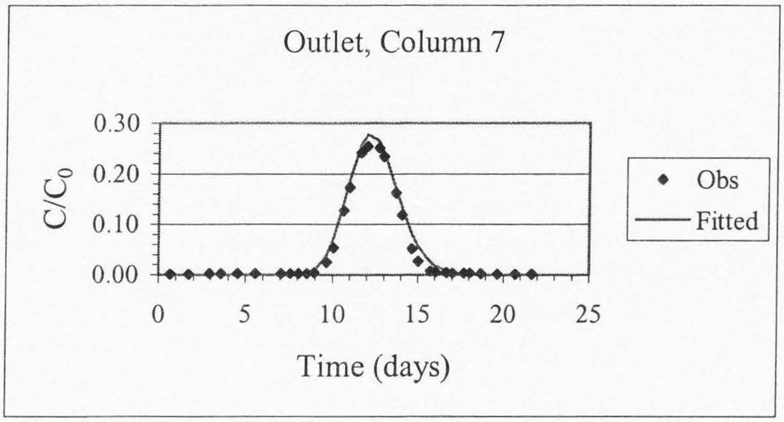

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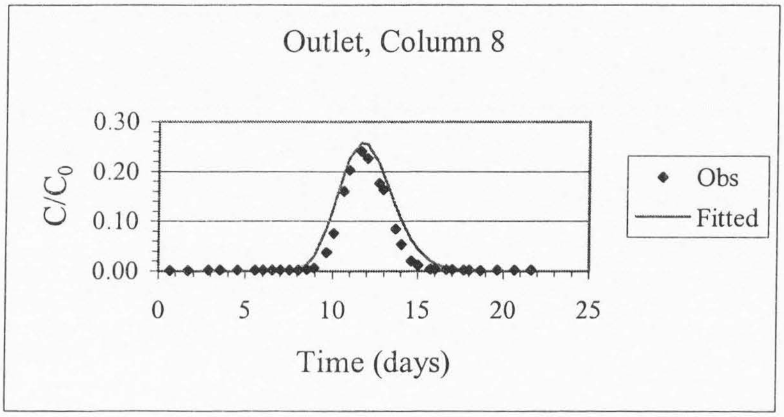

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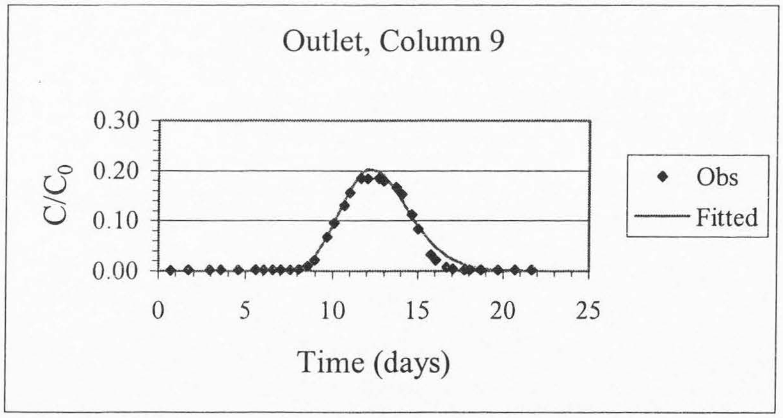


Figure 5-5. (Continued)

Table 5-4. Summary of Outlet Model Data, August 1.

Column Number	1	2	3	4	5	6	7	8	9
Velocity (cm/day)	16.6	15.8	15.8	16.5	14.3	15.8	16.0	16.5	15.4
Dispersion (cm^2/day)	48.7	49.0	28.5	29.1	17.0	28.6	21.5	28.2	38.4
r^2 values	0.962	0.960	0.923	0.963	0.996	0.987	0.981	0.898	0.978

Velocity Comparison (Effluent vs. CXTFIT)

The velocity values given by the effluent measurements and the CXTFIT models are very close. As shown in Table 5-5, the CXTFIT model velocities have an average value of 15.9 cm/day while the effluent velocities have an average of 13.2 cm/day. This variance in the values closely corresponds to the variance during the May 26 tracer test in which the CXTFIT and effluent average velocities were 5.74 cm/day and 3.54 cm/day, respectively. Again, the slight variance is most likely due to the calculation methods involved in the two processes. The effluent velocities are dependent on an estimate of porosity equal to 0.35. The CXTFIT velocities are dependent on the closeness of the fit of the model curve to the observed data curve.

Comparison to Predictive Models

The average peak day for the August 1 bromide tracer test was 12.28 days (see Table 5-3). This corresponds closely, although not perfectly, with the predictive model value for Day 13. The average relative peak concentration of the observed data models was 0.22 (see Table 5-3), which corresponds closely, although not perfectly, with the

Table 5-5. Velocity Comparison Between CXTFIT Values and Calculated Effluent Values, August 1.

Column Number	1	2	3	4	5	6	7	8	9	Avg.
Effluent Velocity (cm/day) (Daily Avgs.)	13.8	13.1	13.7	14.0	11.2	13.2	13.5	13.1	13.1	13.2
CXTFIT Velocity (cm/day)	16.6	15.8	15.8	16.5	14.3	15.8	16.0	16.5	15.4	15.9

value of 0.27 obtained from the two predictive models. Although the dispersion and velocity parameters used in the first predictive model, 1.83 cm^2/day and 15 cm/day, respectively, were adequate starting points for the estimation fitting done by CXTFIT, the higher dispersion estimate of 18.3 cm^2/day, based on Figure 4-2, was a more accurate representation of conditions in the columns. The observed data models, as shown in Tables 5-4 and 5-5, yielded average dispersion and velocity values of 32.1 cm^2/day and 15.9 cm/day, respectively. There is an almost perfect fit for the velocity in the predictive and observed data models. Although the dispersion values are not as close of a match as the velocity values are, the observed data model average value of 32.1 cm^2/day is still less than twice the higher of the two values used in the two predictive models.

Discussion

Hydraulic Conductivity

Calculated hydraulic conductivity measurements for this bromide tracer test were consistent with each other. The average K value was 24.08 cm/day for the hydraulic conductivities calculated using the average tensimeter values and 25.17 cm/day for the average daily calculated K values (see Table 5-1). These average values still keep the soil categorized as a silty sand to fine sand, as was determined in the May 26 bromide tracer test.

Bromide Concentration

The major problems encountered during the May 26 test were not a concern during this second tracer test. The ports that were leaky had already been taken out and replaced with rubber stoppers. Since no samples were taken from Ports A and B, soil clogging in the port and macropore development did not occur.

The results of this second bromide tracer test are in satisfactory agreement with the predictive models created. The values obtained for velocity and retention time are reliable and very consistent among columns. The dispersion values seem to be on the high side, and therefore are not considered as credible as the other parameters discussed here. Because of the general similarity of parameter values among columns, conclusions will be drawn in Chapter 8, and can possibly be applied to other projects concerning this soil and groundwater system.

CHAPTER 6

THIRD BROMIDE TRACER TEST

Methods

Creation and Application of Solution

The bromide tracer solution was made by mixing 22 L of nitrogen-sparged site groundwater with 14.162 g of crystalline sodium bromide (NaBr). This resulted in a bromide solution with an average concentration of 491 mg/L and electrical conductivity (EC) of 1794 μS/cm.

This final bromide tracer test began on January 14. The methods used to apply the bromide tracer solution are identical to those described for the May 26 and August 1 bromide tracer tests. The bromide tracer solution fed the columns for a period of 1 day at a rate of 0.405 mL/min. On January 15, the source reservoir and column caps were switched back to the site groundwater to complete the 1-day pulse. Table C-1 in Appendix C shows the exact times of application and removal of the tracer pulse for each of the nine columns.

Sampling

During this bromide tracer test, samples were removed from the outlet only. This exclusion of the upper ports served to preserve the mass available for analysis at the outlet. Outlet samples were collected as described for the May 26 and August 1 bromide tracer tests.

Analytical Methods

The analytical methods used for this bromide tracer test were the same as described for the May 26 and August 1 tests. Each 20 mL sample was analyzed for electrical conductivity and bromide concentration.

Modeling with CXTFIT

As with the data from the May 26 and August 1 bromide tracer tests, the CXTFIT program was selected for the purpose of modeling the bromide BTCs. The direct problem method provided predictive models and the indirect problem method was used to fit the observed data at the outlet.

Before applying the pulse, a predictive model was created to estimate the retention time for the outlet location. Velocity was estimated to be 9.14 cm/day using Equation 3 with the circulation rate at a value of 0.405 mL/min (583.2 cm^3/day), the cross-sectional area of the column (182.4 cm^2), and an estimate of soil porosity (0.35). Dispersion was given a starting point of 18.3 cm^2/day, approximately one-tenth of the soil length, and more in tune with the dispersions observed during the August 1 bromide tracer test. The initial velocity and dispersion estimates entered in the program for the indirect problem method were 9.14 cm/day and 18.3 cm^2/day, respectively.

Predictive Modeling

Using the estimated velocity and dispersion parameters, the CXTFIT model predicted that the pulse was expected to have an extent of approximately 14 days and that the peak would pass the outlet location 21 days after the pulse was applied to the columns. Figure 6-1 is a graph illustrating the output from this predictive model. The

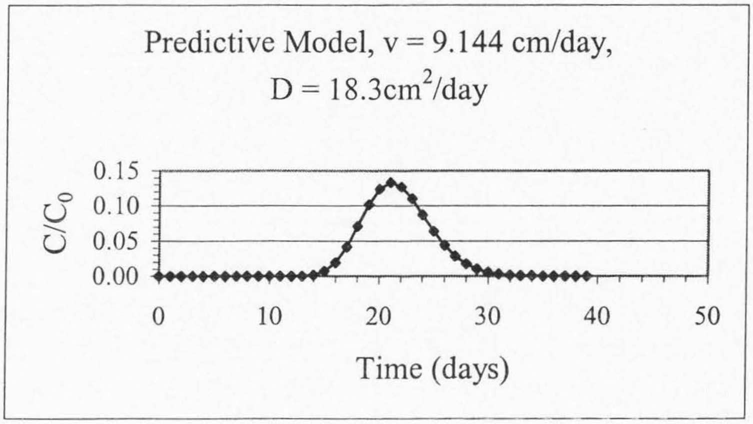


Figure 6-1. CXTFIT predictive model using v = 9.144 cm/day (n = 0.35) and D = 18.3 cm^2/day, January 14.

highest relative concentration value obtained in this model is 0.13. Because the dispersion and porosity estimates were based on results and experience gained from the two previous tracer tests, only one predictive model was necessary to accurately estimate retention time and pulse duration for the January 14 tracer test.

Hydraulic Parameter Data

Hydraulic Conductivity

The Soil Measurement Systems Tensimeter used for the May 26 and August 1 bromide tracer tests was on loan from the Plants, Soils, and Biometeorology Department. Since the hydraulic conductivity values calculated during these two tests were consistent with each other, it was not deemed necessary to borrow the instrument again and take daily measurements of pressure head to calculate hydraulic conductivity during this final bromide tracer test.

Velocity

Steady-state conditions during the entire length of the final bromide tracer test allowed for accurate velocities to be calculated during the time from January 14 to February 17. Table 6-1 shows the input parameters and the average velocities calculated using Equation 2 for each column for the January 14 tracer test. Two sets of velocity data are given in Table 6-1. The first shows velocities calculated with the bulk sums of water weights and time. The second shows an average of the velocity values calculated on a daily basis during the tracer test. As in the August 1 bromide tracer test, the daily averages are more accurate representations of the true velocities in the columns, and are thus used later in comparison to the CXTFIT model calculated velocities. The complete data sets for the effluent weights and velocities is in Tables C-2 and C-3 in Appendix C.

Bromide Concentration Data

A complete listing of the data compiled for the January 14 bromide tracer test can be found in Table C-4 in Appendix C. The data summarized here are in the form of the observed data BTCs at the outlet for each column.

The only location sampled during this tracer test was the outlet at the bottom of the columns. Forty-five samples were taken from each of the nine columns to produce the complete breakthrough curves. Table 6-2 summarizes information about the BTCs for the outlet, including peak day and peak relative concentration. Columns 7 and 8 experienced double peaks, and therefore have retention times equal to the average of the two peak days. The BTCs clearly show the movement of the bromide tracer as it passed through the outlet. All nine outlet BTCs are shown on one plot of relative concentration

Table 6-1. Average Velocity Measured by Effluent Flow from January 14-February 17.

Column Number	1	2	3	4	5	6	7	8	9
Total Weight (kg)	17.79	15.68	16.09	18.19	16.59	19.74	19.03	17.48	17.51
Total Time (day)	34.84								
v Using Total Weights and Times (cm/day)	8.00	7.05	7.24	8.18	7.46	8.88	8.56	7.86	7.88
Average of Daily Calculated v Values (cm/day)	8.05	7.08	7.17	8.20	7.49	8.87	8.59	7.84	7.85

Table 6-2. Summary of the Outlet Data Pertaining to BTCs, January 14.

Column Number	1	2	3	4	5	6	7	8	9	Avg.
Peak Day	20.57	23.53	23.27	21.01	21.01	17.69	18.75	20.41	21.01	20.81
Peak C/C_0	0.14	0.17	0.19	0.16	0.19	0.10	0.18	0.20	0.17	0.17

versus time in Figure 6-2. Figure 6-3 shows the individual curves in more detail by themselves.

Analysis

CXTFIT Models

With CXTFIT, reliable and logical values of velocity and dispersion could be estimated based on the observed data. A complete listing of the CXTFIT data for each of the nine columns can be found in Table C-5 in Appendix C. Figure 6-4 shows the observed data and the fitted curves. Table 6-3 summarizes the information provided by the outlet models, including velocities, dispersions, and r^2 fit values. As evidenced by the high r^2 values, the CXTFIT program fit the data curves quite accurately. Column 6 is the only column with an r^2 value of under 0.929. This is likely because it had a much lower value for the highest concentration ratio at the peak of the pulse, as shown in Table 6-2 and Figure 6-2. The other eight columns mimic each other quite closely in their C/C_0 values. The velocity has an average value of 9.43 cm/day. Some dispersion values are higher than the original estimate of 18.3 cm^2/day but several are lower, giving an almost equal average value of 17.2 cm^2/day. Columns 4, 5, and 9 share identical retention times with a value of 21.01 days. Since the velocity of the August 1 test was the same order of magnitude as the velocity used during this test, it was expected that the dispersion should mirror that relationship and have a value in the same order of magnitude as those calculated in the CXTFIT models of the August 1 data.

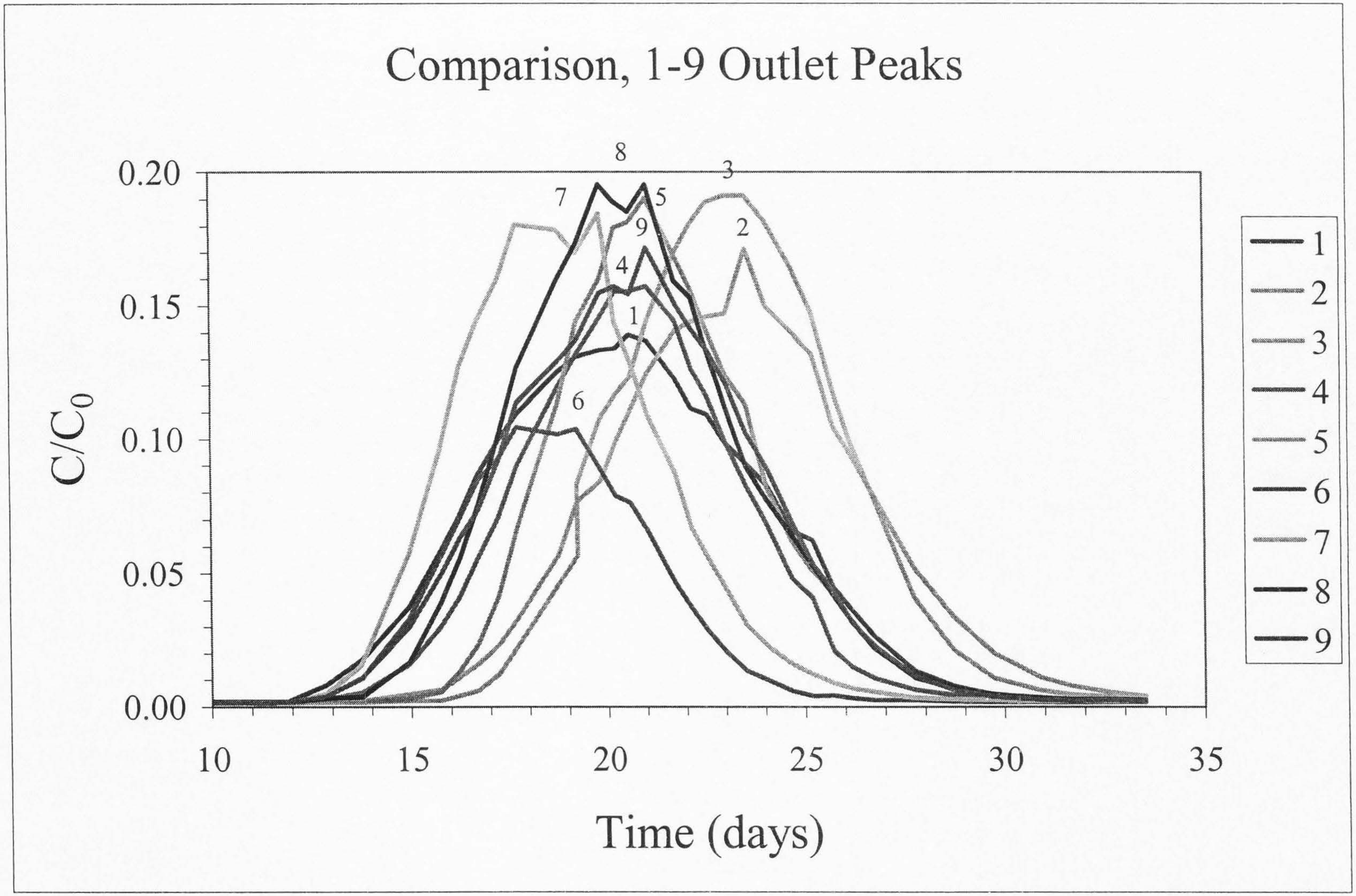
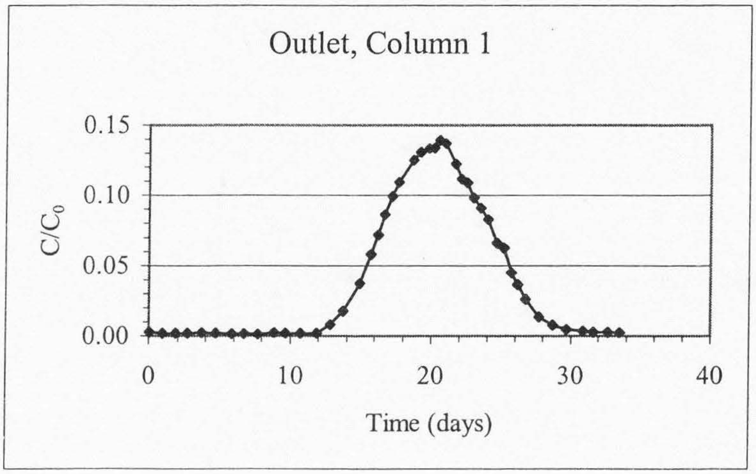


Figure 6-2. Unfitted BTCs for all nine columns at the outlet location, January 14.

A



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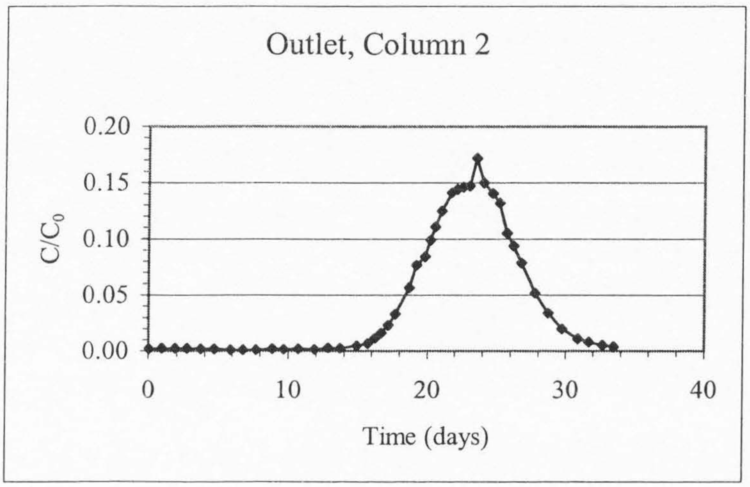

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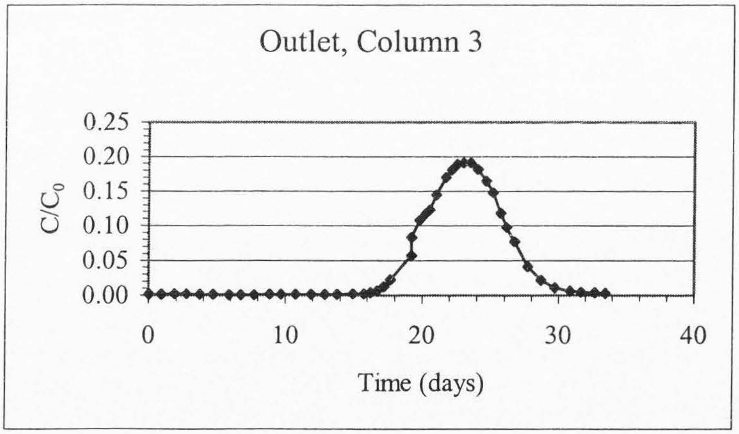
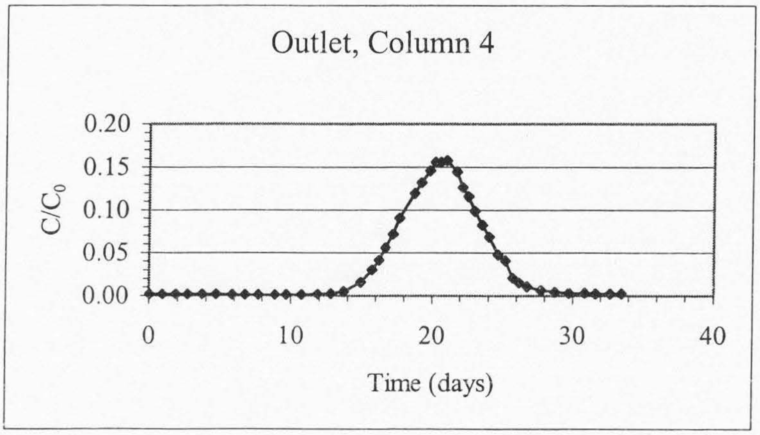


Figure 6-3. Unfitted BTCs for the outlet, January 14. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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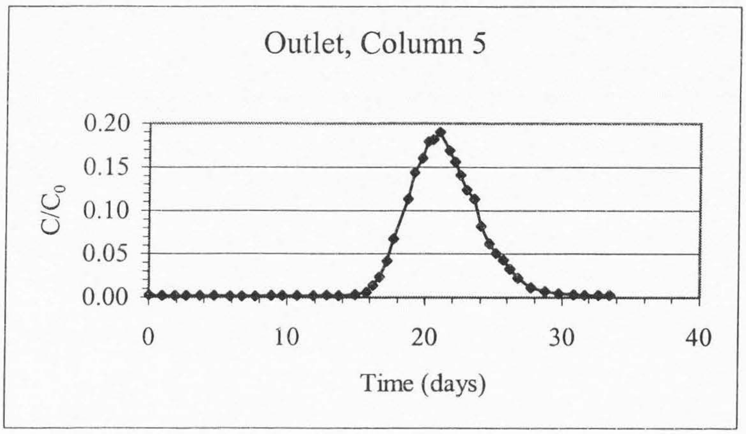

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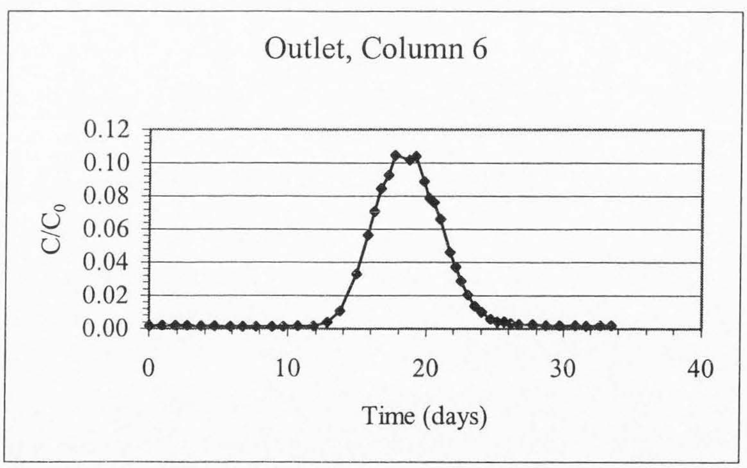

Figure 6-3. (Continued)

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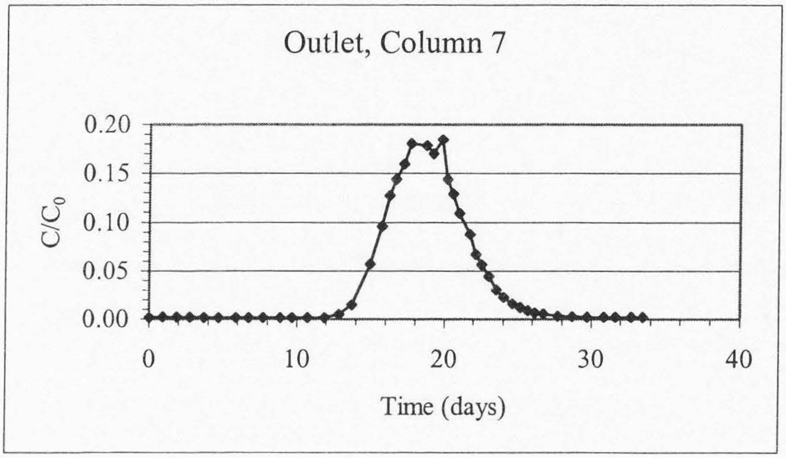

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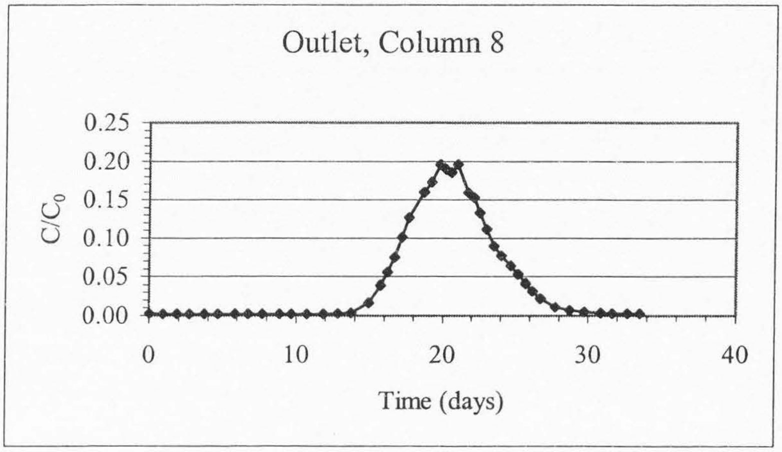

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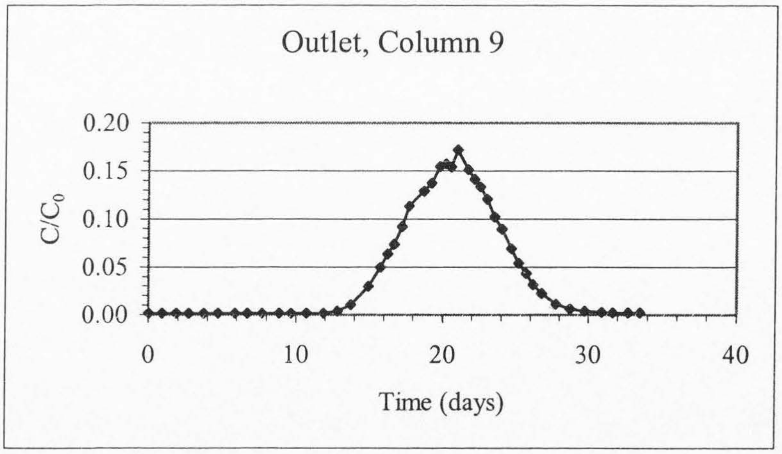

Figure 6-3. (Continued)

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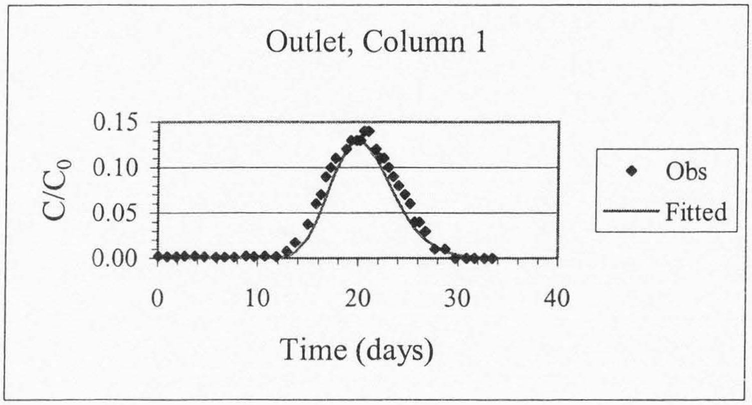

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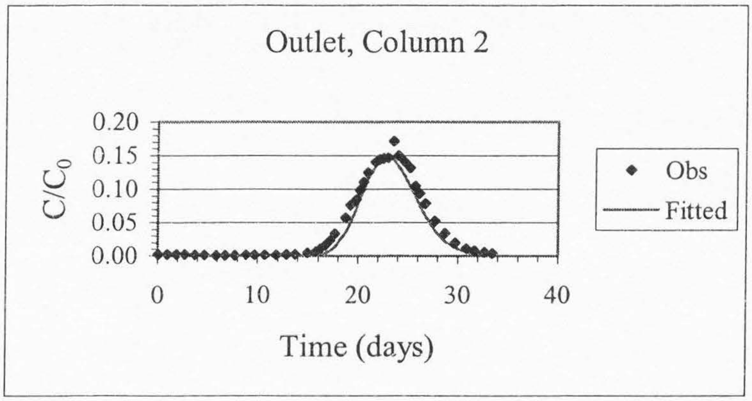

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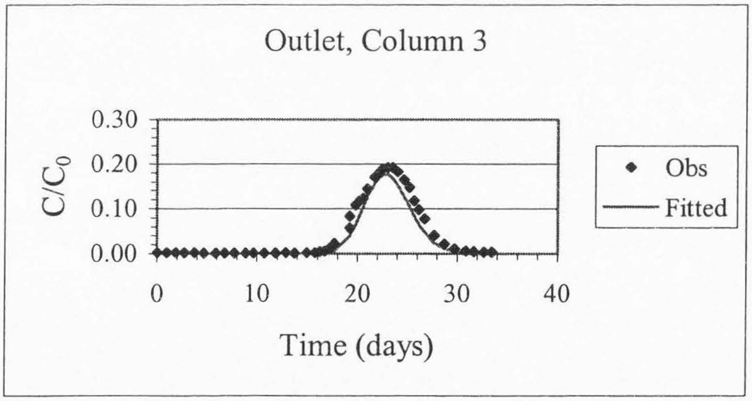
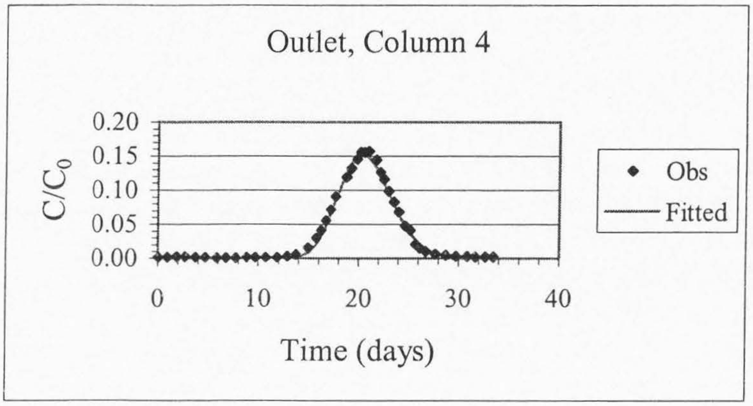


Figure 6-4. Fitted BTCs using CXTFIT for the outlet, January 14. A) Column 1. B) Column 2. C) Column 3. D) Column 4. E) Column 5. F) Column 6. G) Column 7. H) Column 8. I) Column 9.

D



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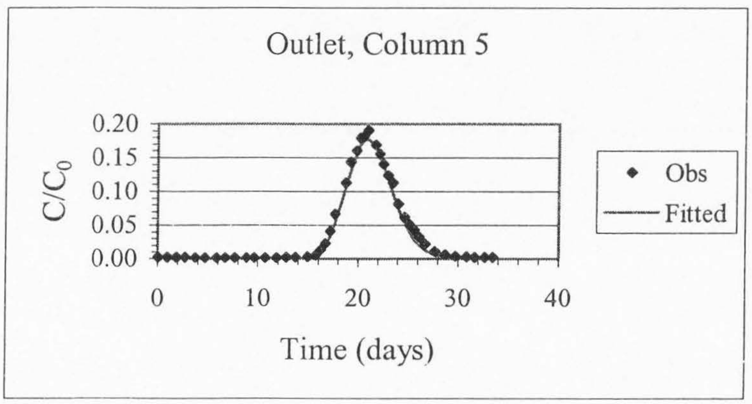

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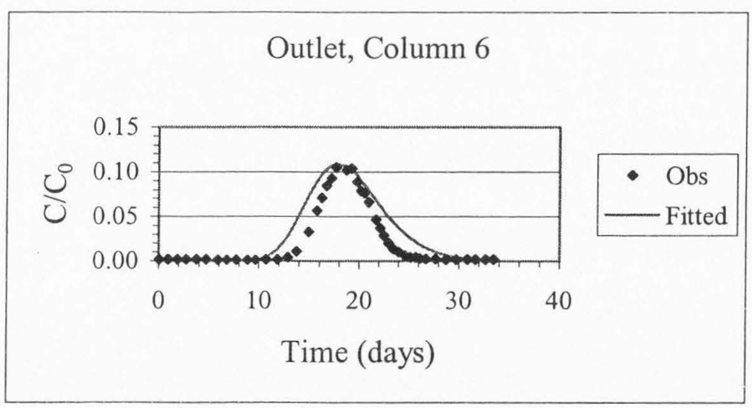

Figure 6-4. (Continued)

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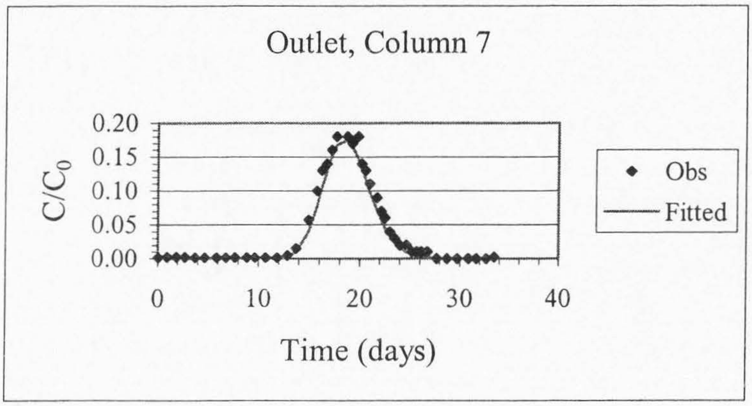

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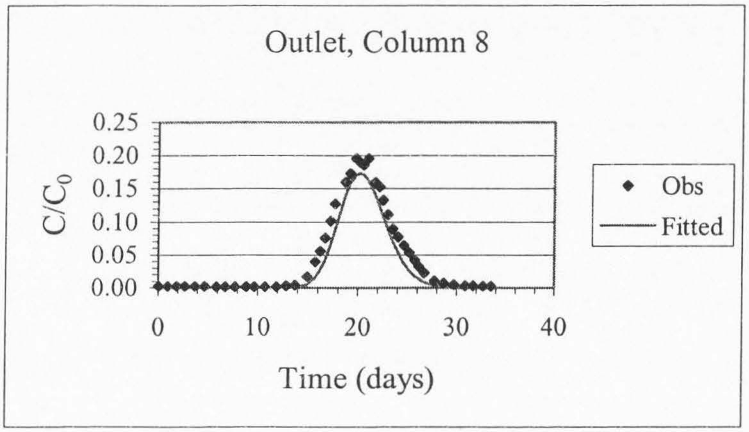

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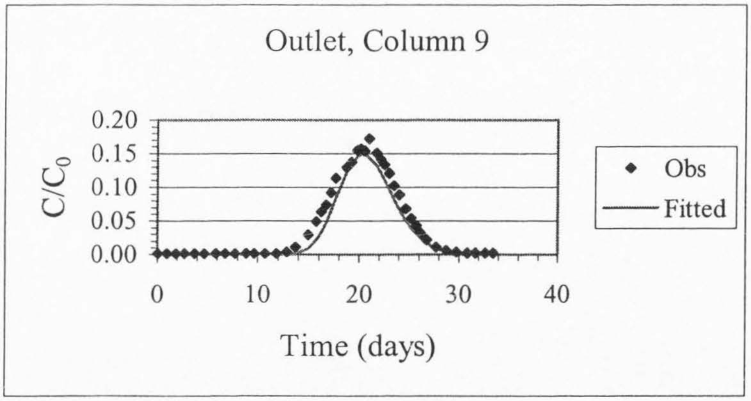


Figure 6-4. (Continued)

Table 6-3. Summary of Outlet Model Data, January 14.

Column Number	1	2	3	4	5	6	7	8	9
Velocity (cm/day)	9.60	8.41	8.55	9.46	9.35	10.4	10.4	9.48	9.21
Dispersion (cm^2/day)	23.0	11.5	8.30	15.3	10.8	43.0	15.4	12.1	15.4
r^2 values	0.953	0.956	0.930	0.992	0.988	0.774	0.974	0.929	0.939

Velocity Comparison (Effluent vs. CXTFIT)

The velocity values given by the effluent measurements and the CXTFIT models are very close. As shown in Table 6-4, the effluent velocities have an average value of 7.90 cm/day, while the CXTFIT model velocities have an average of 9.43 cm/day. Again, the slight variation is most likely due to the calculation methods involved in the two processes. The effluent velocities are dependent on an estimate of porosity in the columns. The CXTFIT velocities are dependent on the closeness of the fit of the model curve to the observed data curve.

Comparison to Predictive Models

The average peak day for the January 14 bromide tracer test was 20.81 days (see Table 6-2). This is nearly identical to the predictive model value for Day 21. The average relative peak concentration value of the observed data models of 0.17 (see Table 6-2) also closely corresponds with the predictive model value of 0.13. The dispersion and velocity parameters used in the predictive model, 18.3 cm^2/day and 9.14 cm/day, were accurate starting points for the estimation fitting done by CXTFIT. The observed

Table 6-4. Velocity Comparison Between CXTFIT Values and Calculated Effluent Values, January 14.

Column Number	1	2	3	4	5	6	7	8	9	Avg.
Effluent Velocity (cm/day) (Daily Avgs.)	8.05	7.08	7.17	8.20	7.49	8.87	8.59	7.84	7.85	7.90
CXTFIT Velocity (cm/day)	9.60	8.41	8.55	9.46	9.35	10.4	10.4	9.48	9.21	9.43

data models, as shown individually in Table 6-3, yielded average dispersion and velocity values of 17.2 cm^2/day and 9.43 cm/day, respectively. Both the dispersion and velocity values are nearly identical to their counterparts in the predictive modeling, showing accurate estimates of column conditions have been achieved.

Discussion

Bromide Concentration

As with the August 1 test, the major problems encountered during the May 26 test were not a concern. The ports that had been leaky were still absent from the system with rubber stoppers in their place. Since no samples were taken from Ports A and B, soil clogging in the port and macropore development did not occur.

The results of this final bromide tracer test reflect the predictions made with CXTFIT prior to the test and correspond closely with the results of the August 1 test. The values obtained for velocity, dispersion, and retention time are reliable and relatively consistent among columns, with the exception of Column 6. The similarity of values among columns suggests that the degree of homogeneity of the nine flow-through column systems is satisfactory for the TCE treatability studies for which the columns were designed.

CHAPTER 7

TCE REDUCTIVE DECHLORINATION MODELING

Introduction

The overall question driving this Hill Air Force Base study is whether the addition of carbon donors and microbial innocula to the groundwater and soil system simulated in the columns is effective in stimulating the reductive dechlorination (degradation) of TCE. The purpose for building the nine soil columns is to conduct laboratory treatability studies using various carbon donors and microbial cultures in an attempt to effectively dechlorinate (degrade) TCE in the system. This section presents several predictive degradation models using four different combinations of carbon donors and microbial cultures.

As outlined in the Hill Air Force Base Draft Work Plan (Utah Water Research Laboratory 2001), microcosms were to be used as a precursor to the column experiments. Selected results from the microcosm studies were chosen to give approximate TCE degradation rates for application in the predictive models for the column study. The source of all background and microcosm data for this modeling exercise is Dr. R. Ryan Dupont of the Utah Water Research Laboratory.

Microcosm Study

System simulations were created in the form of microcosms to study the effectiveness of various carbon donors and microbial populations before they are applied to the large-scale column systems. The microcosms were built in 20-mL headspace vials. Multiple sets of both biotic and abiotic systems were created. Treatments for the microcosm study were constructed using site soil, nutrient solution (11.24 parts ammonia and 1 part yeast in solution with de-ionized water), carbon donor (whey, lactic acid, coconut oil, high melting point oil, low melting point oil, hydrogen releasing compound (HRC), or an emulsified oil), and TCE-amended groundwater (5 mg/L) with a 1:10 dilution of two microbial cultures (MBI Granular or Bachman Road). Evaluations were made of the effectiveness of the carbon donors and microbial communities in enhancing the dechlorination of TCE by examining the changes in concentrations of TCE and its daughter products over a 10-week sampling period. For the predictive modeling in this paper, four treatments were selected to show the progression of TCE degradation as different substances were added to the microcosms. Of the various carbon donors involved in the microcosm experiments, the emulsified oil showed the most promise for enhancing degradation of TCE and was selected for this predictive modeling. Treatment A contained only the basic ingredients (soil, TCE-amended groundwater, nutrient). Treatment X contained the basic ingredients and emulsified oil. Treatment H contained the basic ingredients, emulsified oil, and the Bachman Road microbial culture. Treatment I contained the basic ingredients, emulsified oil, and the Michigan Biotechnology Institute (MBI) granule microbial culture.

Using the data obtained from four selected treatments during these microcosm experiments, first-order degradation rates were estimated and used to create predictive models for the column systems. These predictive models serve to show potential effectiveness of the carbon donors and the microbial cultures and the distance required for reductive dechlorination to occur in the columns.

Degradation Rate Determination

Degradation rates were determined using TCE, cis-DCE, trans-DCE, and VC concentrations measured in the microcosm experiments. Each treatment was individually investigated, and the complete data sets are available in Appendix D in Table D-1. Degradation rates were determined by linear regression of the contaminant concentration curves. BIOCHLOR takes into account the molecular weights of the compounds, so it was not necessary to normalize the concentrations to each other. A summary of rates determined for each treatment, effective rates, and the r^2 fit for the regressions can be found in Table 7-1. Trans-DCE is not included in the table because cis-DCE was the dominant form produced during dechlorination. Trans-DCE was not produced in measurable amounts under any of the treatments. Also, the biotic rates reported for cis-DCE and VC are equal to the effective rates, since no measurable dechlorination occurred in the abiotic microcosms. Figure 7-1 shows the changes in contaminant concentrations from the microcosm study for Treatments, X, H, and I. Treatment A showed no measurable degradation, and therefore was not included here. These graphs were used to determine the points used in the linear regressions for determining the degradation rates of TCE and its daughter products. Trans-DCE was also omitted from these graphs, since it was not used in the TCE reductive dechlorination modeling.

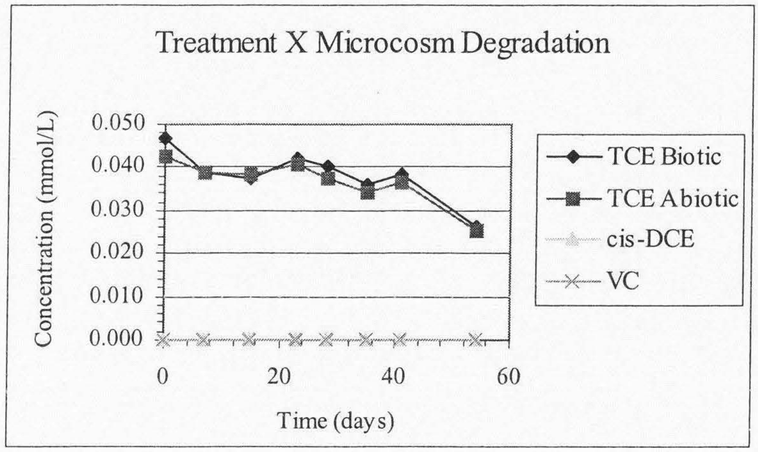
Treatment A

Treatment A contained only the basic ingredients and was not expected to show any signs of TCE degradation. The microcosms experienced no measurable decrease in the concentration of TCE and no measurable production of intermediate products. From

Table 7-1. Summary of Degradation Rates Estimated by Linear Regression of Contaminant Concentration Curves Obtained in Microcosm Study.

TCE Degradation Rates				
	Treatment A	Treatment X	Treatment H	Treatment I
Biotic rate (day^{-1})	0.0000	0.0073	0.6174	0.3232
r^2	n/a	0.6124	0.8842	0.7583
Abiotic rate (day^{-1})	0.0000	0.0076	0.0027	0.0031
r^2	n/a	0.6957	0.1704	0.3132
Effective rate (day^{-1})	0.0000	0.0000	0.6147	0.3201
cis-DCE Degradation Rates				
Biotic rate (day^{-1})	0.0000	0.0000	0.0374	0.0724
r^2	n/a	n/a	0.6996	0.9625
VC Degradation Rates				
	0.0000	0.0000	0.3572	0.1297
	n/a	n/a	0.9283	1.000*
*Incomplete data, only two measurements were available for the linear regression.				

A



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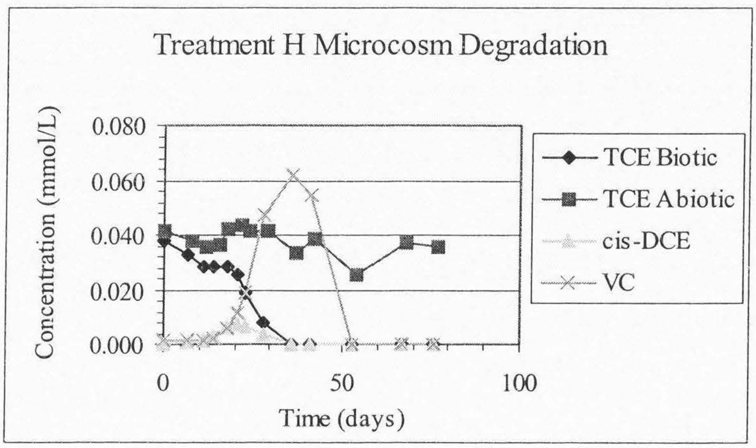

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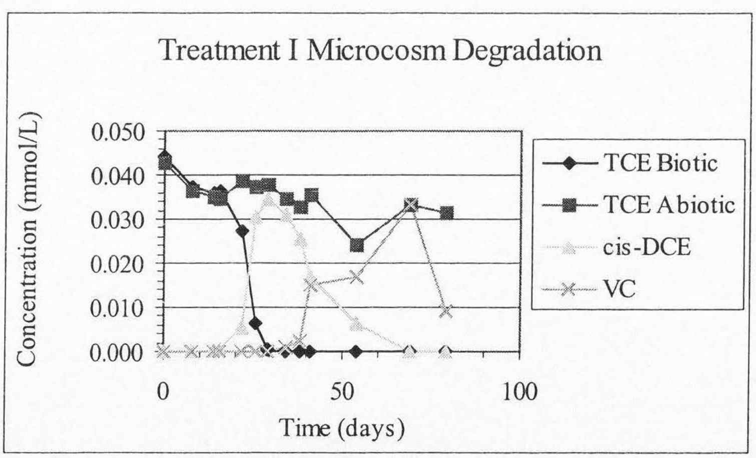


Figure 7-1. Microcosm results, used for degradation rate determination. A) Treatment X, B) Treatment H, C) Treatment I

this information, it was determined that the degradation rate was equal to zero for modeling purposes and no regression was necessary.

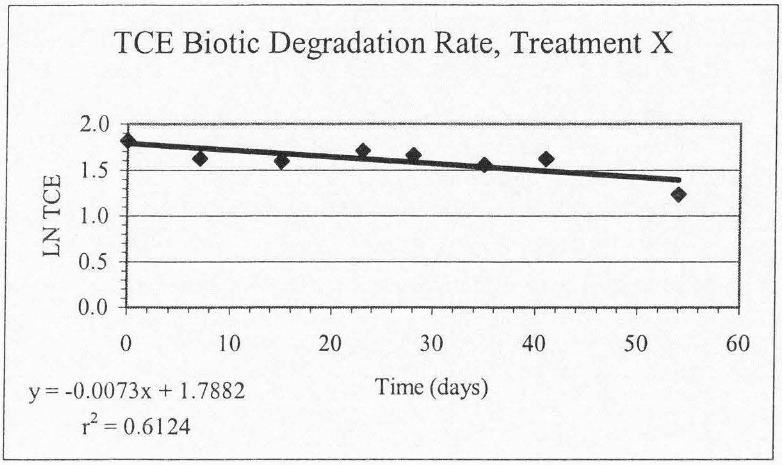
Treatment X

The only additional ingredient in Treatment X was the emulsified oil as the carbon donor. Regression of the curve for the biotic microcosms, as shown in Figure 7-2A, yielded a first-order degradation rate of 0.0073 day^{-1}. Regression of the curve for the abiotic systems, illustrated in Figure 7-2B, gave a degradation rate of 0.0076 day^{-1}. Both of these linear regressions used all points available (eight) for Treatment X in Figure 7-1A. The difference between the abiotic rate and the biotic rate gives an effective degradation rate equal to -0.0003 day^{-1}. This negative rate shows that there was technically more degradation of TCE in the abiotic system than the biotic system. The effective rate for TCE in Treatment X was input as zero for two reasons. First, a negative degradation rate cannot be entered into BIOCHLOR. Second, the effective rate value is nearly zero and clearly shows the ineffectiveness of the carbon donor to stimulate the dechlorination process on its own. There was no measurable production of intermediate products using Treatment X, and therefore the rates of degradation for cis-DCE and VC are equal to zero.

Treatment H

Treatment H included the emulsified oil and the Bachman Road microbial culture. As seen in Figure 7-3, regressions yielded a biotic rate of 0.6174 day^{-1} and an abiotic rate of 0.0027 day^{-1} for TCE. The biotic linear regression used four points from Day 18 to Day 28, showing the greatest slope in Figure 7-1B for TCE degradation. As with

A



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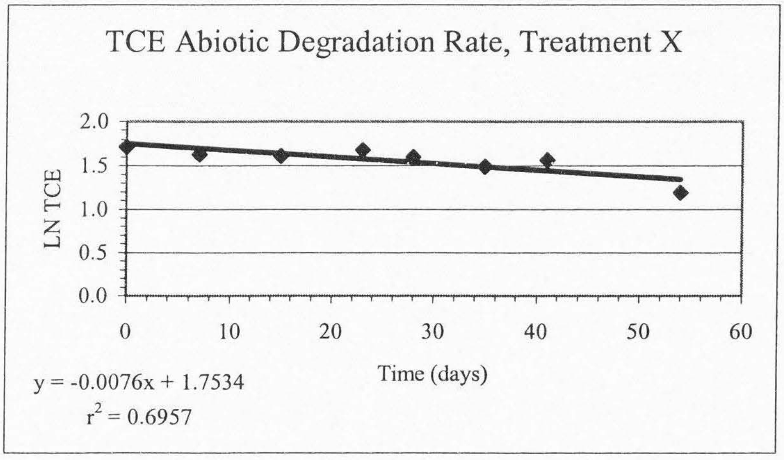


Figure 7-2. Linear regressions for TCE for Treatment X. A) Biotic, B) Abiotic.

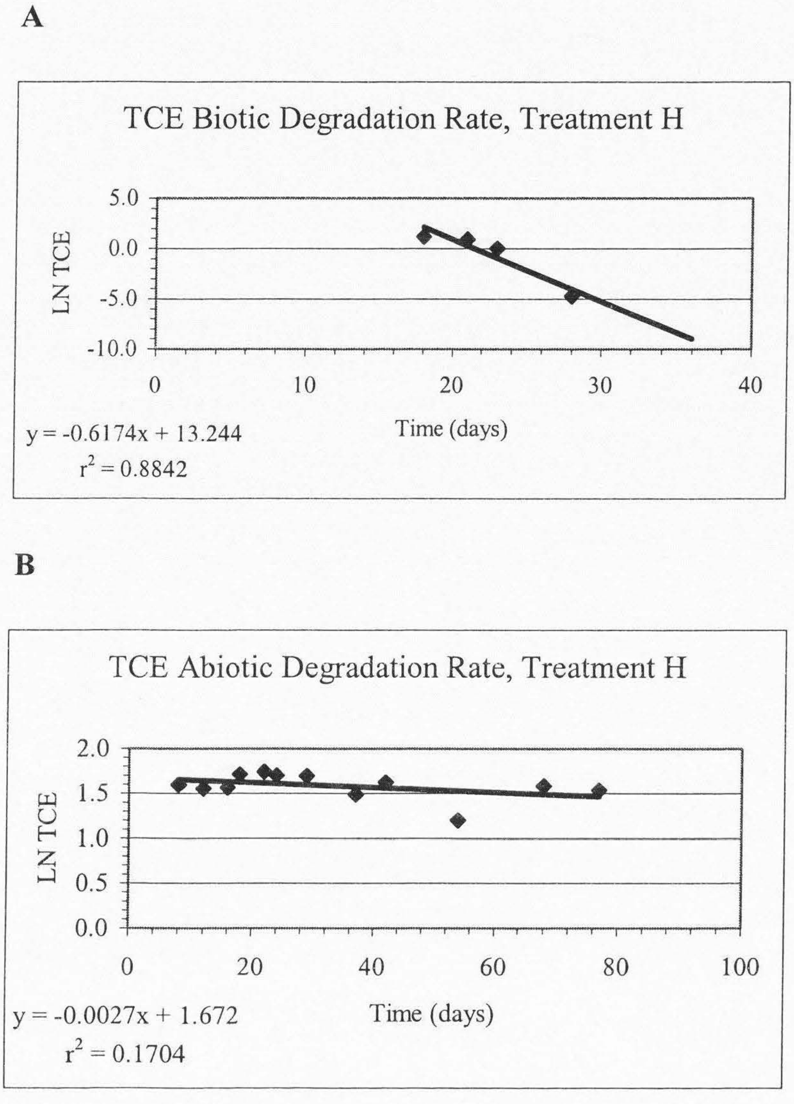


Figure 7-3. Linear regressions for TCE for Treatment H. A) Biotic, B) Abiotic.

Treatment X, all points available in Figure 7-1B were used for the abiotic linear regression. The effective rate of TCE degradation equaled 0.6147 day^{-1}. Since Treatment H showed significant degradation of TCE, it also showed production of intermediate products. Regression of the cis-DCE and VC concentrations gives estimates of these degradation rates. Figures 7-4 and 7-5 show the linear regressions for cis-DCE and VC for Treatment H. cis-DCE was degraded at a rate of 0.0374 day^{-1}, while VC was degraded at a rate of 0.3752 day^{-1}. Four points were used from Day 4 to Day 28 in the cis-DCE linear regression, and three points from Day 36 to Day 53 were used in the VC linear regression. These points were chosen in the same manner as the TCE points. They represent the portion of the curve shown in Figure 7-1B that corresponds to degradation of the compound. No intermediate products were produced in the abiotic systems so the biotic degradation rates are equal to the effective degradation rates.

Treatment I

Treatment I consisted of the emulsified oil and the MBI granule microbial population. For Treatment I, all points shown in Figure 7-1C were used for the linear regression of abiotic TCE, while four points from Day 16 to Day 28 were used for biotic TCE. Again, these four points represent the period of degradation of TCE in the microcosms. Linear regressions for TCE show a biotic rate of 0.3230 day^{-1}, and an abiotic rate of 0.0031 day^{-1} as illustrated in Figure 7-6. Subtracting the abiotic rate from the biotic rate yields an effective TCE degradation rate of 0.3201 day^{-1}. As with Treatment H, Treatment I showed significant degradation of TCE and experienced production of intermediate products. The linear regression of the cis-DCE degradation

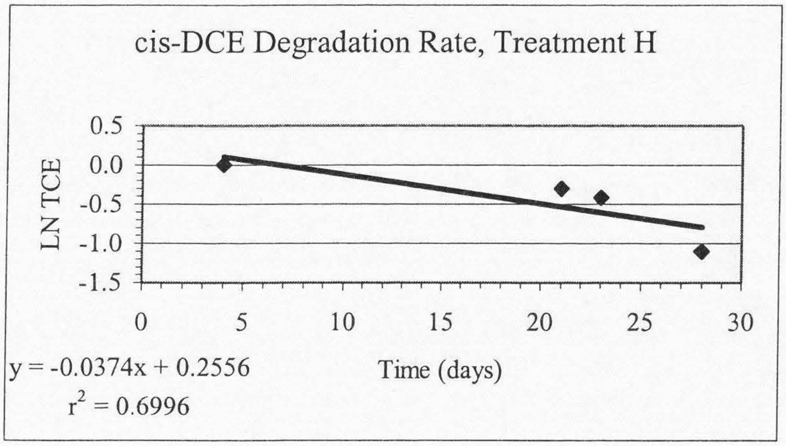


Figure 7-4. Linear regression for cis-DCE for Treatment H.

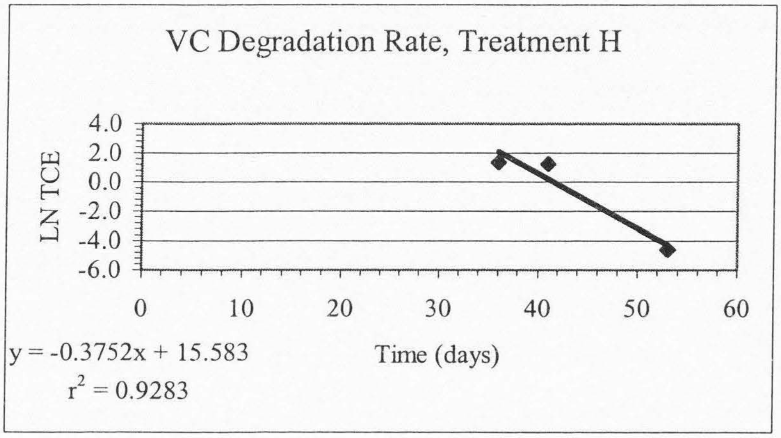
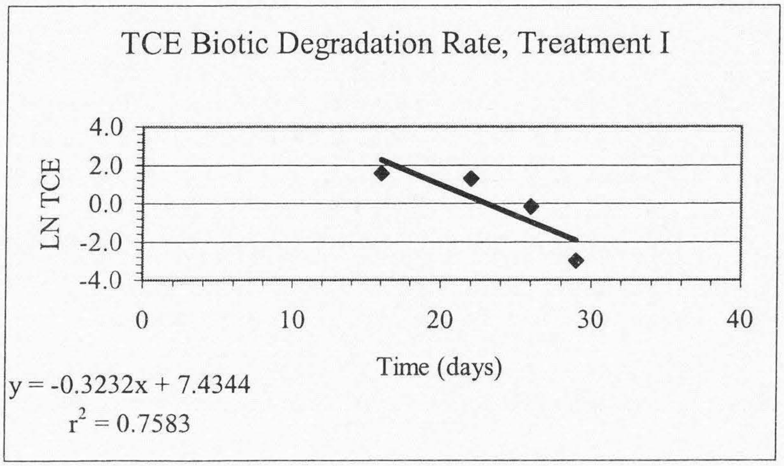


Figure 7-5. Linear regression for VC for Treatment H.

A



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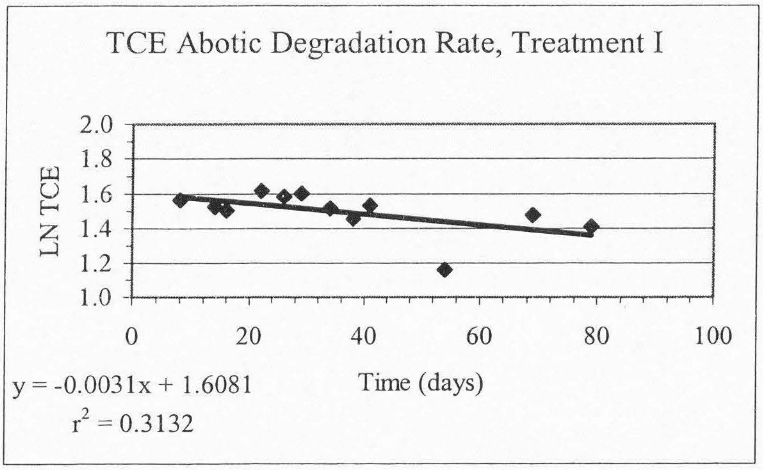

Figure 7-6. Linear regressions for TCE for Treatment I. A) Biotic, B) Abiotic.

rate is shown in Figure 7-7, and Figure 7-8 shows the regression for VC. Five points, from Day 28 to Day 53, as shown in Figure 7-1C, represent the periods of degradation for cis-DCE, and two points, on Days 69 and 79, for VC. The linear regression for VC is considered incomplete since the period of degradation consisted of only two points. The degradation values were still used in BIOCHLOR to show potential degradation for the compound. cis-DCE was degraded at a rate of 0. 0724 day^{-1} while VC was degraded at a rate of 0.1297 day^{-1}. Again, no intermediate products were produced in the abiotic systems, so the biotic degradation rates are equal to the effective degradation rates.

Column Modeling

Input Parameters

BIOCHLOR was selected as the most appropriate modeling program for the flow-through column system built for this study. This program is written specifically for the first-order degradation of chlorinated ethenes (PCE, TCE, DCE, VC) in an Excel format, and requires the input of several hydraulic and contaminant parameters. Selected parameters can also be calculated based on other input information. Velocity was input directly as 109.6 ft/year (9.144 cm/day). This is the same velocity as the January 14 bromide tracer test, and was chosen because it is an approximation of the field site groundwater velocity. Longitudinal dispersivity was also input directly, and had a value of 0.6 ft (18.3 cm). This value represents one-tenth of the soil length and was obtained by using the statistical illustration shown in Figure 4-2. The dispersivity ratios of transverse to longitudinal and horizontal to longitudinal were input as constants with

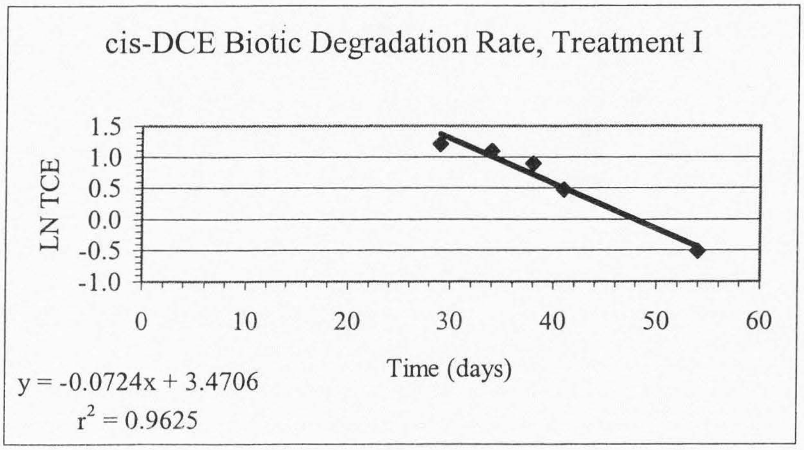

Figure 7-7. Linear regression for cis-DCE for Treatment I.

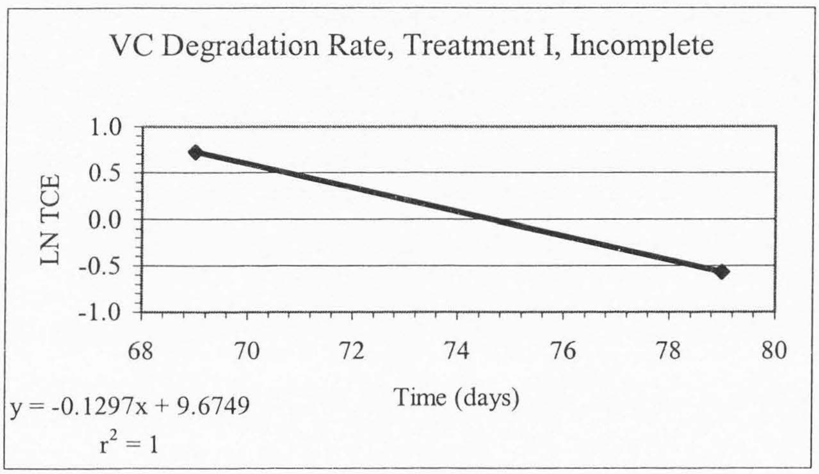

Figure 7-8. Linear regression for VC for Treatment I.

values of 0.1 ft and 0.05 ft, as suggested in the BIOCHLOR User's Manual (US EPA 2000).

The next group of parameters was required to calculate an average retardation (R) value to be used in the program. Bulk density (ρ) equal to 1.6 kg/L, a porosity (n) of 0.35, and a fraction of organic carbon (f_{oc}) of 0.003 were used for calculating the retardation factor for each of the chlorinated ethenes, along with their individual partition coefficients, according to Equation 5:

$$R = 1 + \frac{K_{oc} f_{oc} \rho}{n} \tag{5}$$

The soil to water partition coefficients (K_{oc}) for TCE, cis-DCE, and VC were obtained from the Environmental Fate Database CHEMFATE (Syracuse Research Corporation 2002). K_{oc} values input for TCE, DCE, and VC were 100, 43, and 29.5, respectively. Calculations using Equation 4 yielded retardation values of 2.37, 1.59, and 1.40 for TCE, DCE, and VC, respectively. The K_{oc} value for ethylene given in the CHEMFATE database was 98. This is not a reasonable value since it is higher than the value given for VC. The K_{oc} value should get progressively smaller as chlorine atoms are removed from the compound structure. Therefore, a hand estimation of the K_{oc} for ethylene was necessary. The K_{oc} for ethylene was determined by using its correlation with K_{ow} as shown in Equation 6 (from Gerstl 1990):

$$\log K_{oc} = 0.679 \log K_{ow} + 0.663 \tag{6}$$

where the log K_{ow} for ethylene was equal to 1.13 and obtained from the CHEMFATE database. This equation yielded a log Koc value of 1.43, which corresponds to a K_{oc} value of 26.9. Using Equation 5, a retardation factor of 1.37 was calculated for ethylene.

Taking all four retardation factors into account, BIOCHLOR calculated a common retardation value for the model equal to 1.40. PCE values can also be input in the program, but were excluded in an attempt to make the program-calculated retardation factor more applicable to TCE dechlorination and behavior.

The next input section was for the degradation rates of TCE to DCE, DCE to VC, and VC to ethylene. BIOCHLOR uses units of $year^{-1}$, so the rates calculated using the linear regressions described above needed to be converted from per day to per year. Table 7-2 summarizes the rates in this new unit required for input into BIOCHLOR.

The final input sections, which remained identical for all four treatments, were those pertaining to the system dimensions and the initial concentration of the contaminant. Simulation time was input as 0.5 years (6 months). This is the length of time the TCE reductive dechlorination experiments are expected to run using the columns. The width of the system is equal to the diameter of the columns, which is 0.5 ft (15.24 cm). The program has an option of two zones in the length, with one being a permanent source and the other being a down-gradient, non-source area. For the purposes of this study, only one zone was necessary. TCE will be present along the entire length of the soil column, and therefore is a constant source equal to the length of the soil. On the output graph, zone 1 is broken into ten equal-length sections for more detail. Zone 1 was given a length of 30 ft to be able to later show changes at the 3 ft and 6 ft points on the output graph, as well as show what would potentially happen down-gradient when this technology is applied to the field site at Hill Air Force Base. As stated above, only one zone was necessary, so the input length for Zone 2 was zero. Finally, the initial concentration of TCE was input as 7 mg/L, since the ideal concentration that will

Table 7-2. Effective Degradation Rates Converted to Year^{-1} for Input into BIOCHLOR.

TCE Degradation Rates				
	Treatment A	Treatment X	Treatment H	Treatment I
Effective rate (year^{-1})	0.0	0.0	224.5	116.9
cis-DCE Degradation Rates				
Biotic rate (year^{-1})	0.0	0.0	13.7	26.4
VC Degradation Rates				
Biotic rate (year^{-1})	0.0	0.0	130.5	47.4*
*Incomplete data, only two measurements were available for the linear regression.				

be applied to the columns is an average value between 5 and 10 mg/L. A summary of the BIOCHLOR output data used to create the illustrations described below is provided in Table D-2 in Appendix D.

Treatments A and X Models

Since they had identical input parameters, one model was run to represent systems under either Treatment A or Treatment X. The input degradation rates for Treatment A and Treatment X were equal to zero. Therefore, it was expected that the BIOCHLOR model would show that both the abiotic TCE and biotic TCE concentration lines to be nearly identical. This is evident in Figure 7-9 where the lines representing the two systems are identical. At the 6-foot and 30-foot points in the model, the TCE

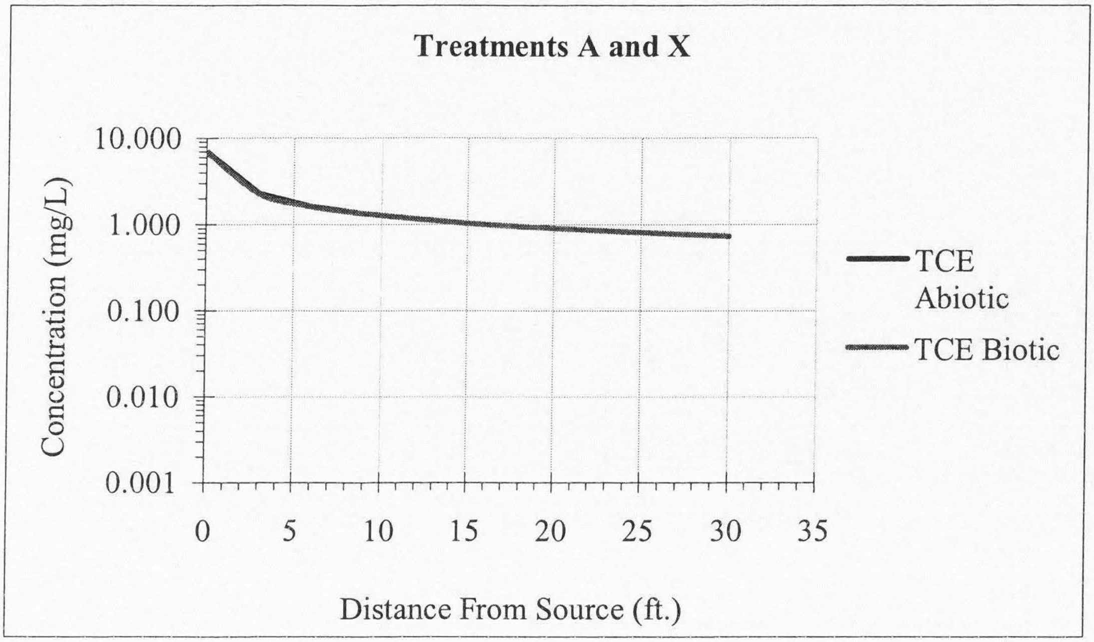

Figure 7-9. Treatments A and X BIOCHLOR model.

concentrations are 1.62 mg/L and 0.733 mg/L, respectively. The groundwater has transported the TCE the full 30 feet over the 6-month simulation time.

Treatment H Model

Treatment H was the first in this series of systems to have an introduced microbial population involved in the microcosm. Since degradation was observed in the microcosms, measurable degradation of TCE and production and degradation of cis-DCE, VC, and ethylene were expected in this BIOCHLOR model. As illustrated in Figure 7-10, TCE was almost completely degraded and the intermediate products were produced within the 6-foot length of the column. At the 6-foot point, TCE had a concentration of only 0.001 mg/L and was completely degraded by the 7-foot mark. cis-DCE decreases over an order of magnitude by the end of the model length (30 ft) from

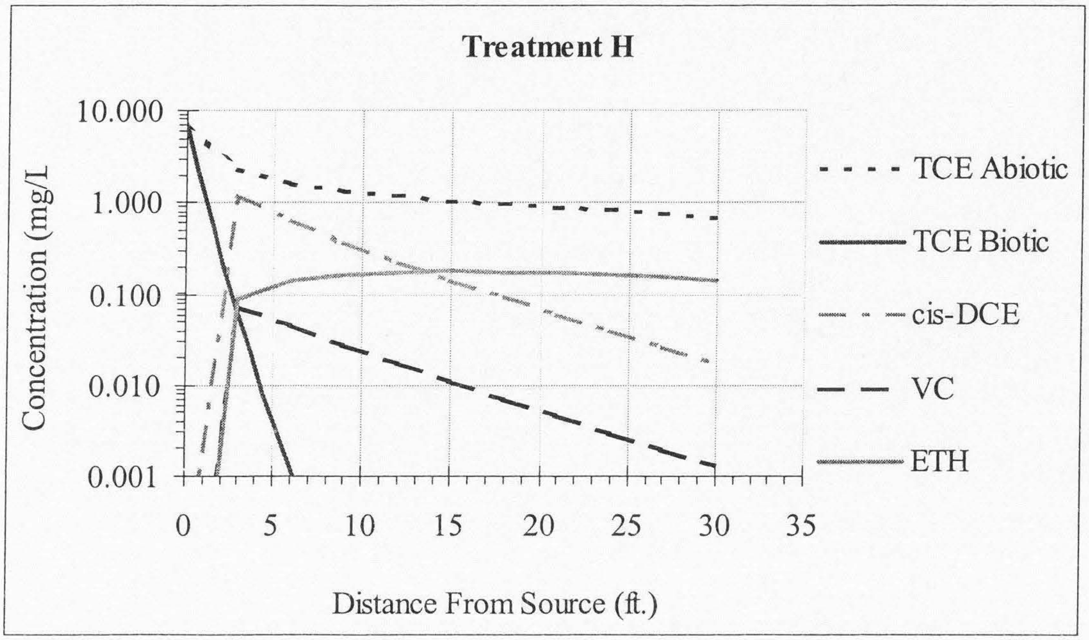

Figure 7-10. Treatment H BIOCHLOR model.

0.632 mg/L, at the 6-foot point, to only 0.017 mg/L, at the 30-foot point. VC also decreases significantly along the model length from 0.046 mg/L at the 6-foot mark to 0.001 mg/L at the 30-foot mark. Ethylene remains relatively constant through the model length and has values of 0.143 mg/L at 6 feet and 0.147 mg/L at 30 feet.

Treatment I Model

Treatment I also involved the introduction of a microbial population into the system. Figure 7-11 shows the BIOCHLOR illustration for Treatment I. In this model, the TCE was completely removed from the system by the 10-foot mark. The concentration of TCE at 6 feet was 0.019 mg/L. The two environmentally harmful daughter products, cis-DCE and VC were nearly completely degraded by the 30-foot model length. At six feet, cis-DCE had a concentration of 0.410 mg/L and decreased over two orders of magnitude to 0.001 mg/L at the 30-foot point. VC had a concentration

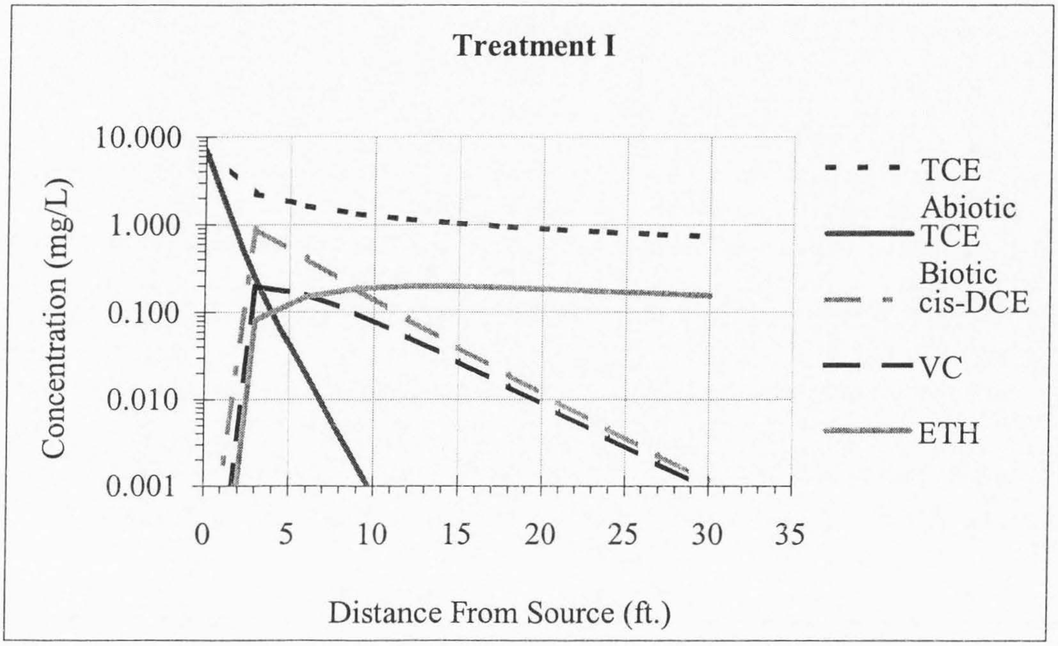

Figure 7-11. Treatment I BIOCHLOR model.

of 0.160 mg/L at the 6-foot point, which decreased over three orders of magnitude to only 0.001 mg/L at 30 feet. As with Treatment H, the ethylene concentration remained constant over the distance from 6 to 30 feet with values of 0.152 mg/L and 0.156 mg/L at those two points.

Discussion

Parameter Input

Overall, the input parameters are simple to establish and the Excel format makes it easy to run the program. The only input parameters that could potentially have a large influence on the outcome of the model are the retardation factors. Since each contaminant (PCE, TCE, DCE, VC, and ethylene) has an individual retardation factor, the degradation and production rates and distances could have different values if each individual retardation was used instead of the common retardation value employed by BIOCHLOR. Excluding PCE from the input data helped bring the retardation value down to a more reasonable number that more closely reflected the individual retardations of TCE and the daughter products produced in the microcosms. Also, using the K_{ow} correlation to estimate the K_{oc} for ethylene ultimately gave a more credible retardation factor value for ethylene.

BIOCHLOR Models

The models are representative of a variety of treatments that were used in the microcosm experiments, and accurately reflect potential conditions of degradation in the flow-through column system. The most likely application of this predictive modeling is to determine which microbial population is most effective in degrading TCE and its intermediate products along the length of the columns. According to the BIOCHLOR models, Treatment H (Figure 7-10) was most effective in degrading TCE in the shortest length. However, Treatment I (Figure 7-11) was most effective in degrading cis-DCE, since it showed a concentration near zero by the end of the 30-foot model length. Both Treatment H and Treatment I were effective in degrading VC to a concentration of nearly zero by the end of the 30-foot model length and the two treatments show similar levels of ethylene concentrations over the model distance. Since Treatments H and I show the most encouraging signs of TCE, cis-DCE, VC, and ethylene degradation, microbial amendments will be necessary to ensure the effectiveness of the carbon-enhanced dechlorination process. Considering that the TCE plume from which the soil and groundwater was derived for this study is more than 10,000 feet in length, a significant decrease of the toxic daughter products (cis-DCE and VC) over only a 30-foot length shows that carbon-enhanced dechlorination has the potential to be a successful remediation technology for the contaminated areas at Hill Air Force Base.

CHAPTER 8

CONCLUSIONS

Column Construction

In the objectives at the beginning of this paper, it was stated that the columns would be built and prepared for the bromide tracer tests and TCE degradation experiments. The columns were packed to a bulk density of 1.6 kg/m^3, and they were saturated using de-ionized water. The fine-grained nature of the soil made achieving complete uniformity difficult. The soil homogenization and packing methods were as successful as possible in creating uniformity among columns. After saturation, site groundwater was to be circulated at an estimated site groundwater velocity to simulate field conditions in the soil columns. Each of these objectives was met during construction of the soil columns. There was some inconsistency surrounding the estimated site groundwater velocity as written in the Hill AFB Work Plan (Utah Water Research Laboratory, 2001). However, the correct groundwater velocity was soon determined and applied to the flow-through column systems.

The only major flaw encountered during column construction was the initiation of leakage from the side ports. The ports were designed to be gas tight, but some seals were insufficient in this effort. The problem was remedied in both minor and major ways. Some ports were effectively sealed by applying a small amount of parafilm around the interface between the removable port and the glass column. The remaining leaks, which were not remedied by using parafilm, were solved by removing the port and replacing it with a rubber stopper. With the leakage problems solved, as they have been since the end of June, this flow-through column system is ready to simulate the aquifer conditions in mind for the TCE treatability studies.

Tracer Tests

Many alterations were made to the system, and much was learned during the running of all three bromide tracer tests, especially the first one on May 26. The objectives for the bromide tracer tests included finding retention times in the columns, ensuring that the hydraulic conditions were acceptable to run the carbon-enhanced TCE dechlorination experiments, and to determine whether significant changes had occurred in the columns over time. Retention times were established during each individual tracer test. The most recent test run on January 14 is the most applicable retention time due to the fact that the velocity used during this test (9.144 cm/day) is the velocity being used during the TCE dechlorination experiments.

A solid understanding of the hydraulic conditions within the columns was also achieved during the tracer tests. Some difficulty was encountered during the first test as it took several weeks for the system to reach steady-state conditions. As discussed in Chapter 4, some negative values for hydraulic conductivity (K) were calculated, after all the columns had reached steady state on June 23, due to unusually low tensimeter measurements, especially in Column 7. Since the daily average K values excluding the negative values more accurately represented steady-state conditions in the columns, they are used here for comparison to the second tracer test K values. The hydraulic conductivity was determined to have an average value among columns of 77.7 cm/day during the May 26 test and 25.2 cm/day during the August 1 test. Table 8-1 provides

Table 8-1. Summary Table for Hydraulic Conductivity. All K Values in cm/day.

Column Number	1	2	3	4	5	6	7	8	9
Daily Calculated K June 23-July 26 (excluding negatives)	19.71	59.06	16.06	44.30	47.89	32.12	434.88	18.37	27.14
Daily Calculated K August 1-August 21	19.12	20.39	7.41	30.05	28.61	29.12	52.45	22.03	17.35

a summary of these hydraulic conductivity values. The higher average of the May 26 test is a result of a much higher K value for Column 7. This column had a much lower average head measurement than the other columns during this test causing the calculation of a higher average K value. During the second testing period, from August 1-23, Column 7 yielded an average K value similar to the other eight columns. This suggests that the higher K value obtained during the May 26 test is an anomaly and an average for this testing period can be adjusted to exclude Column 7. The average value for the eight columns excluding Column 7 for the May 26 test is 33.1 cm/day. This agreement of values (33.1 cm/day and 25.2 cm/day), despite drastic differences in velocity and pulse duration during the two tests, verifies that the conditions in the columns are constant and the calculation methods are applicable to varying situations in the flow-through column systems. A similar comparison was made with the bulk average hydraulic conductivity values for both testing periods. During the first test, the bulk average K had a value of

61.5 cm/day, including Column 7, and 30.7 cm/day, excluding Column 7. The bulk average K calculated during the second test was 24.1 cm/day. These numbers closely parallel those of the daily calculated averages and support the Chapter 4 conclusion that either method of calculation for hydraulic conductivity (bulk average or daily average) produces reliable and accurate values reflective of the conditions in the columns.

Even though the velocities differed between the three tests, the differences in CXTFIT fitted velocities and calculated effluent velocities remained nearly equal. A summary of these velocities can be found in Table 8-2. On average, the CXTFIT velocity had a larger value by 2.1 cm/day, 2.7 cm/day, and 1.5 cm/day during the May 26, August 1, and January 14 tracer tests, respectively. Individual columns showed consistency as well. For example, Column 8 had the largest difference between velocities during both the May 26 and August 1 tests. In general, the columns that had higher velocities in CXTFIT also had higher effluent velocities and tended to continue that trend across the three bromide tracer tests.

Another measurement of the success of the tracer tests is the agreement between observed results and the predictive models created with CXTFIT. Since the May 26 test encountered so many difficulties and required the modification of the modeling program, the predictive models had no relationship to the ultimate fitted graphs produced for this paper. The August 1 and January 14 tests, however, had incredible precision and accuracy between the observed data and the predictive model retention times and relative concentrations. The second predictive model for the August 1 test, using a velocity of 15 cm/day and a dispersion of 18.3 cm^2/day, yielded a retention time (peak day) of 13

Table 8-2. Summary Table for Velocities. All Values in cm/day.

Column Number	1	2	3	4	5	6	7	8	9
May 26 Test									
Effluent Velocity	3.85	2.26	4.04	3.84	2.96	3.98	3.95	3.86	3.83
CXTFIT Velocity	5.63	4.12	6.00	5.96	5.19	6.12	5.80	6.47	6.41
August 1 Test									
Effluent Velocity	13.8	13.1	13.7	14.0	11.2	13.2	13.5	13.1	13.1
CXTFIT Velocity	16.6	15.8	15.8	16.5	14.3	15.8	16.0	16.5	15.4
January 14 Test									
Effluent Velocity	8.05	7.08	7.17	8.20	7.49	8.87	8.59	7.84	7.85
CXTFIT Velocity	9.60	8.41	8.55	9.46	9.35	10.4	10.4	9.48	9.21

days with a peak relative concentration (C/C_0) of 0.27. As shown in Table 8-3, the average retention time among columns was 12.3 days and the average C/C_0 value was 0.22. Similarly corresponding values occurred between the predicted models and observed data for the January 14 test. The predictive model, using a velocity of 9.14 cm/day and a dispersion of 18.3 cm^2/day, yielded a C/C_0 value of 0.13 and a retention time of 21 days. As seen in Table 8-3, the average observed relative concentration was 0.17 and the retention time was 20.9 days. The agreement between the values for retention time and relative concentration for both the August 1 and January 14 tests show that they were each successful and provided reliable data for analysis of the hydraulic conditions in the columns.

The final objective associated with the bromide tracer tests was to determine and describe changes in the soil system over time. Macropores were developed around the sampling ports during the May 26 test, but these did not cause detrimental effects on the water flow in subsequent tracer tests. There was no evidence of channeling through the center of the columns or along the glass surfaces of the edges of the columns during any of the tracer tests. Based on the observations described in this and the individual tracer test sections, there were no significant changes in dead space development or overall hydraulic conditions during the time elapsed between tracer tests.

Overall, the parameters estimated by CXTFIT for the May 26 tracer test are inaccurate. Any comparison of changes over time can only be made between the August 1 and January 14 tracer tests. The pulse time of 3 days in the May 26 test, along with the port leakage, created problems in the running of CXTFIT and thus the results produced by the program. The results from the latter two tests are consistent with one another and

Table 8-3. Summary of Predictive and Observed Model Data.

	Predicted	Observed
August 1 Retention Time	13 days	12.3 days
August C/C_0	0.27	0.22
January 14 Retention Time	21 days	20.9 days
January C/C_0	0.13	0.17

satisfy all the objectives outlined for this project.

TCE Reductive Dechlorination Modeling

The purpose of creating predictive models for the dechlorination of TCE was to determine whether the available treatments would be effective along the length available in the flow-through column system. As discussed in Section 7, the four treatments showed predictable results in the modeling using BIOCHLOR. Treatments A and X showed virtually no dechlorination along the column length. This suggests that the addition of a carbon donor alone is not effective enough to stimulate dechlorination of TCE and its daughter products under these column conditions.

As the microbial populations were added, dechlorination of TCE and production and degradation of its intermediate products were observed. Treatment H, with the Bachman Road microbial community, seemed to be more effective than Treatment I, with the MBI granule microbial population, in completely degrading TCE faster, as shown in Figures 7-10 and 7-11. Both VC and cis-DCE were degraded along a shorter length of soil under Treatment I than Treatment H. Considering that the TCE plume from which the soil and groundwater was derived from this study is more than 10,000 feet in length, a significant decrease of the toxic daughter products (cis-DCE and VC) over only a 30-foot length shows that carbon-enhanced dechlorination with microbial amendments has the potential to be a successful remediation technology for the contaminated areas at Hill Air Force Base.

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APPENDICES

Appendix A. First Bromide Tracer Test

Table A-1. Test 1 Tracer Application Data.

Column	5/26/02 Begin Pulse	5/29/02 End Pulse
1	2:25 PM	3:56 PM
2	2:28 PM	4:01 PM
3	2:30 PM	3:25 PM
4	2:32 PM	3:44 PM
5	2:35 PM	3:38 PM
6	2:38 PM	3:29 PM
7	2:42 PM	3:08 PM
8	2:45 PM	2:50 PM
9	2:47 PM	2:57 PM

Table A-2. Test 1 Tensimeter Measurements. (2 pages)

Pressure Transducer Values (1 mbar = 1 cm H_2O)

		Columns (values in mbars)									
Date	Time	1	2	3	4	5	6	7	8	9	
5/25/02	1:45p	13	-4	12	-3	-1	16	5	-7	0	
5/26/02	10:10a	70	6	103	44	36	42	24	4	55	
5/26/02	3:45p	26	0	27	12	18	5	0	-4	13	
5/27/02	11:35a	57	7	52	32	31	24	6	-13	37	
5/28/02	9:30a	57	-8	21	33	30	22	4	-16	7	
5/29/02	10:30a	58	-25	70	33	31	32	23	2	36	
5/30/02	9:05a	59	-9	78	39	40	36	35	38	41	
5/31/02	8:55a	53	-13	60	35	38	36	0	35	34	
5/31/02	3:40p	44	-20	28	17	23	-4	-23	15	31	
6/1/02	11:45a	48	-12	57	36	36	13	-6	17	33	
6/2/02	12:00p	47	-20	59	24	34	-1	-7	7	33	
6/3/02	8:50a	49	-18	59	31	32	-9	-5	38	37	
6/4/02	9:10a	44	-19	60	26	32	-16	-12	31	38	
6/4/02	3:40p	46	-32	43	12	33	-23	-22	16	30	
6/5/02	9:45a	46	-25	61	30	35	-19	-12	25	32	
6/6/02	9:00a	45	-10	61	28	32	-21	-22	23	38	all columns not dripping
6/7/02	9:15a	44	-6	49	27	28	0	-13	-36	37	
6/8/02	1:00p	30	-22	33	2	11	-10	-13	-37	21	
6/9/02	12:30p	42	-3	52	18	25	0	1	-4	39	
6/10/02	12:00p	23	-44	23	-10	0	-20	-33	13	10	
6/11/02	1:35p	41	-10	46	22	19	-8	15	31	33	
6/12/02	9:40a	40	-13	47	23	20	5	16	27	33	
6/13/02	1:35p	45	-13	48	29	21	8	22	33	33	
6/14/02	8:50a	44	-21	37	-52	22	-12	19	33	32	
6/14/02	4:40p	9	-14	11	-30	5	6	-12	8	15	
6/15/02	1:45p	-3	-47	23	-53	21	7	15	4	30	
6/17/02	8:15a	23	-25	40	-20	18	-36	26	-31	28	
6/18/02	8:25a	28	-45	27	-17	5	-3	-7	-18	31	
6/19/02	8:05a	37	-32	43	-56	23	-19	18	-29	36	
6/19/02	2:00p	37	-16	43	-17	23	-4	18	-20	36	
6/20/02	8:10a	37	-17	32	-40	25	-18	-32	-29	33	
6/20/02	6:05p	31	-32	47	-53	22	-11	-27	-23	30	
6/21/02	8:15a	33	-11	53	7	21	1	34	15	36	
6/22/02	9:20a	38	-13	53	34	24	31	33	35	33	
6/23/02	9:40a	38	18	50	31	26	34	31	36	33	
6/24/02	8:15a	39	23	48	30	26	34	29	35	33	
6/25/02	8:20a	29	9	40	17	16	28	16	32	29	
6/26/02	7:55a	43	15	45	28	27	35	24	36	34	
6/27/02	8:00a	42	20	50	31	28	36	24	36	34	
6/28/02	2:30p	43	25	45	29	28	36	24	40	35	
6/29/02	10:05a	43	22	48	28	25	34	22	41	32	
6/30/02	7:50a	45	23	45	28	26	35	21	39	32	all columns dripping
7/1/02	6:30a	45	24	46	29	26	33	22	39	32	
7/2/02	9:15a	44	23	46	29	25	32	20	38	31	
7/3/02	9:35a	41	23	47	50	25	33	24	39	32	
7/4/02	11:00a	42	25	47	27	27	33	24	40	32	
7/5/02	9:10a	45	25	45	28	26	35	26	40	32	
7/6/02	10:35a	47	24	56	27	25	39	21	40	33	
7/7/02	10:45a	47	24	54	29	27	34	22	42	33	
7/8/02	9:40a	45	25	51	30	27	32	22	41	32	

7/9/02	3:25p	43	26	54	35	26	35	26	43	34	all columns dripping
7/10/02	9:50a	40	25	51	29	25	33	22	41	33	
7/11/02	9:35a	41	26	51	28	26	35	28	44	32	
7/12/02	4:15p	44	26	53	31	28	34	23	52	34	
7/13/02	10:10a	45	25	50	31	30	34	21	49	34	
7/14/02	11:35a	45	25	50	27	31	33	20	50	36	
7/15/02	9:30a	45	20	51	27	29	35	23	50	35	
7/16/02	10:15a	48	18	49	30	29	33	24	51	36	
7/17/02	10:35a	44	13	46	29	29	33	23	54	37	
7/18/02	9:55a	45	21	39	26	28	30	24	55	37	
7/19/02	9:15a	49	23	47	28	28	33	22	65	36	
7/20/02	10:35a	42	27	50	28	29	33	22	64	37	
7/21/02	10:40a	40	31	51	108	28	32	23	53	36	
7/22/02	8:40a	40	31	49	28	28	33	21	55	35	
7/23/02	10:00a	40	33	49	28	29	33	23	55	35	
7/24/02	10:45a	39	31	48	48	28	32	20	53	36	
7/25/02	9:55a	39	32	49	28	29	32	22	86	38	
7/26/02	9:30a	40	38	49	28	29	32	22	58	47	
Avg measurement		42.56	24.09	48.50	32.00	27.03	33.47	22.97	46.82	34.32	

*All averages calculated from 6/23-7/26

Table A-3. Test 1 Daily and Bulk Average Hydraulic Conductivity Calculations. (2 pages)

Hydraulic Conductivity Values (K=(QL/AΔh)*1440) cm/day

		Columns (values in cm/day)									
Date	Time	1	2	3	4	5	6	7	8	9	
5/25/02	1:45p	-83.364	-23.331	-61.102	-20.690	-24.861	-152.202	-27.443	-17.343	-25.429	
5/26/02	10:10a	8.903	-47.889	5.488	18.207	24.861	19.852	181.127	-30.062	11.867	
5/26/02	3:45p	61.133	-29.352	61.102	-65.027	919.844	-32.615	-21.061	-19.605	-98.889	
5/27/02	11:35a	11.909	-53.523	14.100	35.014	34.068	91.321	-29.214	-14.091	22.821	
5/28/02	9:30a	11.909	-19.360	305.510	32.513	36.794	152.202	-25.875	-12.884	-42.381	
5/29/02	10:30a	11.608	-11.233	9.075	32.513	34.068	35.124	301.878	-26.525	24.054	
5/30/02	9:05a	11.321	-18.569	7.834	22.759	20.441	26.859	33.542	23.733	18.936	
5/31/02	8:55a	13.290	-15.963	11.315	28.449	22.435	26.859	-21.061	28.183	26.970	
5/31/02	3:40p	17.980	-12.815	53.913	-227.593	83.622	-19.852	-10.176	-112.731	32.963	
6/1/02	11:45a	15.542	-16.544	12.220	26.776	24.861	-76.101	-16.466	-225.461	28.710	
6/2/02	12:00p	16.088	-12.815	11.602	91.037	27.874	-22.830	-15.888	-37.577	28.710	
6/3/02	8:50a	15.033	-13.581	11.602	37.932	31.719	-16.307	-17.087	23.733	22.821	
6/4/02	9:10a	17.980	-13.187	11.315	65.027	31.719	-13.046	-13.517	37.577	21.707	
6/4/02	3:40p	16.673	-9.578	19.501	-65.027	29.672	-10.872	-10.410	-150.308	35.600	
6/5/02	9:45a	16.673	-11.233	11.043	41.381	26.281	-12.016	-13.517	75.154	30.690	
6/6/02	9:00a	17.302	-17.841	11.043	50.576	31.719	-11.415	-10.410	112.731	21.707	
6/7/02	9:15a	17.980	-21.160	15.534	56.898	43.802	-24.032	-13.125	-8.199	22.821	
6/8/02	1:00p	39.870	-12.132	33.946	-26.776	-70.757	-15.745	-13.125	-8.052	127.143	
6/9/02	12:30p	19.511	-24.592	14.100	-455.186	61.323	-24.032	-22.089	-19.605	20.698	
6/10/02	12:00p	101.889	-7.646	130.933	-15.696	-26.281	-11.708	-8.309	-75.154	-59.334	
6/11/02	1:35p	20.378	-17.841	17.293	151.729	306.615	-16.911	-69.664	37.577	28.710	all columns
6/12/02	9:40a	21.326	-15.963	16.664	113.796	183.969	-32.615	-82.330	56.365	28.710	not dripping
6/13/02	1:35p	17.302	-15.963	16.079	45.519	131.406	-41.510	905.635	32.209	28.710	
6/14/02	8:50a	17.980	-12.464	26.187	-6.411	102.205	-14.729	-181.127	32.209	30.690	
6/14/02	4:40p	-48.263	-15.422	-53.913	-9.290	-36.794	-35.124	-13.517	-40.993	-178.001	
6/15/02	1:45p	-21.326	-7.279	130.933	-6.322	131.406	-38.051	-69.664	-30.062	35.600	
6/17/02	8:15a	101.889	-11.233	22.354	-11.671	919.844	-8.302	100.626	-9.018	42.381	
6/18/02	8:25a	48.263	-7.520	61.102	-12.644	-36.794	-20.755	-15.888	-12.187	32.963	
6/19/02	8:05a	24.784	-9.578	19.501	-6.069	83.622	-12.016	-129.376	-9.394	24.054	
6/19/02	2:00p	24.784	-14.443	19.501	-12.644	83.622	-19.852	-129.376	-11.562	24.054	
6/20/02	8:10a	24.784	-13.998	36.661	-7.715	61.323	-12.341	-8.464	-9.394	28.710	
6/20/02	6:05p	36.680	-9.578	16.664	-6.322	102.205	-15.220	-9.336	-10.736	35.600	
6/21/02	8:15a	31.621	-17.168	13.680	-37.932	131.406	-25.367	36.225	-112.731	24.054	
6/22/02	9:20a	23.513	-15.963	13.680	30.346	70.757	38.051	39.375	28.183	28.710	
6/23/02	9:40a	23.513	181.979	15.025	37.932	54.108	30.440	47.665	26.525	28.710	
6/24/02	8:15a	22.366	60.660	16.079	41.381	54.108	30.440	60.376	28.183	28.710	
6/25/02	8:20a	43.667	-69.992	22.354	-227.593	-306.615	50.734	-82.330	34.686	38.696	
6/26/02	7:55a	18.714	-909.897	17.971	50.576	48.413	28.538	181.127	26.525	26.970	
6/27/02	8:00a	19.511	101.100	15.025	37.932	43.802	26.859	181.127	26.525	26.970	
6/28/02	2:30p	18.714	47.889	17.971	45.519	43.802	26.859	181.127	21.473	25.429	
6/29/02	10:05a	18.714	69.992	16.079	50.576	61.323	30.440	905.635	20.496	30.690	
6/30/02	7:50a	17.302	60.660	17.971	50.576	54.108	28.538	-905.635	22.546	30.690	
7/1/02	6:30a	17.302	53.523	17.293	45.519	54.108	32.615	905.635	22.546	30.690	all columns
7/2/02	9:15a	17.980	60.660	17.293	45.519	61.323	35.124	-301.878	23.733	32.963	dripping
7/3/02	9:35a	20.378	60.660	16.664	14.683	61.323	32.615	181.127	22.546	30.690	
7/4/02	11:00a	19.511	47.889	16.664	56.898	48.413	32.615	181.127	21.473	30.690	
7/5/02	9:10a	17.302	47.889	17.971	50.576	54.108	28.538	100.626	21.473	30.690	
7/6/02	10:35a	16.088	53.523	12.555	56.898	61.323	22.830	-905.635	21.473	28.710	
7/7/02	10:45a	16.088	53.523	13.283	45.519	48.413	30.440	905.635	19.605	28.710	
7/8/02	9:40a	17.302	47.889	14.548	41.381	48.413	35.124	905.635	20.496	30.690	
7/9/02	3:25p	18.714	43.328	13.283	28.449	54.108	28.538	100.626	18.788	26.970	

Q (mL/min)	0.3	
A (cm^2)	182.41	
		L (cm)
h1 (cm)	18.5	193.6
h2 (cm)	15.5	192.1
h3 (cm)	19.5	193.5
h4 (cm)	19.0	192.2
h5 (cm)	17.5	194.2
h6 (cm)	19.0	192.8
h7 (cm)	21.5	191.2
h8 (cm)	19.0	190.4
h9 (cm)	17.5	187.9

7/10/02	9:50a	21.326	47.889	14.548	45.519	61.323	32.615	905.635	20.496	28.710	
7/11/02	9:35a	20.378	43.328	14.548	50.576	54.108	28.538	69.664	18.037	30.690	
7/12/02	4:15p	17.980	43.328	13.680	37.932	43.802	30.440	301.878	13.664	26.970	
7/13/02	10:10a	17.302	47.889	15.025	37.932	36.794	30.440	-905.635	15.031	26.970	
7/14/02	11:35a	17.302	47.889	15.025	56.898	34.068	32.615	-301.878	14.546	24.054	
7/15/02	9:30a	17.302	101.100	14.548	56.898	39.993	28.538	301.878	14.546	25.429	
7/16/02	10:15a	15.542	181.979	15.534	41.381	39.993	32.615	181.127	14.091	24.054	
7/17/02	10:35a	17.980	-181.979	17.293	45.519	39.993	32.615	301.878	12.884	22.821	
7/18/02	9:55a	17.302	82.718	23.501	65.027	43.802	41.510	181.127	12.526	22.821	all columns dripping
7/19/02	9:15a	15.033	60.660	16.664	50.576	43.802	32.615	905.635	9.803	24.054	
7/20/02	10:35a	19.511	39.561	15.025	50.576	39.993	32.615	905.635	10.021	22.821	
7/21/02	10:40a	21.326	29.352	14.548	5.114	43.802	35.124	301.878	13.262	24.054	
7/22/02	8:40a	21.326	29.352	15.534	50.576	43.802	32.615	-905.635	12.526	25.429	
7/23/02	10:00a	21.326	25.997	15.534	50.576	39.993	32.615	301.878	12.526	25.429	
7/24/02	10:45a	22.366	29.352	16.079	15.696	43.802	35.124	-301.878	13.262	24.054	
7/25/02	9:55a	22.366	27.573	15.534	50.576	39.993	35.124	905.635	6.730	21.707	
7/26/02	9:30a	21.326	20.220	15.534	50.576	39.993	35.124	905.635	11.562	15.085	
		19.71	20.22	16.06	36.30	37.46	32.12	196.95	18.37	27.14	Daily avg. w/negatives
		19.71	59.06	16.06	44.30	47.89	32.12	434.88	18.37	27.14	Daily avg. w/out negatives

(Average tensimeter values found below are from Table A-2)

42.56	24.09	48.50	32.00	27.03	33.47	22.97	46.82	34.32	Avg. tensimeter values
19.06	52.97	15.80	35.01	48.26	31.55	307.92	16.21	26.45	K w/avg tensimeter values

*All averages calculated from 6/23-7/26

Table A-4. Test 1 ΔW Values for Effluent Velocity Calculations.

Time	Water Weights (values in grams)									
	1	2	3	4	5	6	7	8	9	
5/25/02 13:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(empty bottles)
5/30/02 14:30	1120.1	0.0	689.0	570.5	1088.0	25.6	317.4	2.8	834.9	
6/1/02 13:00	612.8	0.0	520.5	208.0	496.1	47.1	1.0	26.1	524.4	
6/3/02 15:00	697.8	0.0	633.8	95.6	672.4	0.0	1.0	71.4	630.5	
6/5/02 15:30	575.3	0.0	558.0	316.9	649.7	0.0	1.0	19.3	540.3	
6/8/02 13:00	794.1	0.0	760.3	337.9	313.8	0.0	1.0	0.0	801.5	
6/11/02 15:00	850.6	0.0	823.5	3.0	408.4	0.0	1.0	62.4	843.3	
6/14/02 8:50	479.8	-0.1	476.3	84.0	154.9	0.1	441.3	235.4	645.3	all columns not dripping
6/17/02 15:25	2.4	-0.1	405.9	0.1	253.7	0.3	232.2	51.4	605.6	
6/20/02 16:45	67.2	-0.1	257.1	0.2	224.7	0.0	2.7	0.2	952.9	
6/22/02 16:05	518.7	0.0	777.8	436.4	288.4	127.4	652.5	48.1	738.2	
6/24/02 9:55	456.1	140.8	630.1	618.2	354.8	635.9	563.7	360.7	626.5	
6/25/02 8:10	418.8	58.1	720.8	712.9	471.1	694.5	692.5	692.0	703.2	
6/28/02 14:35	609.8	148.2	844.1	807.7	533.1	821.7	770.1	803.8	780.5	
6/30/02 16:05	514.6	357.9	760.1	738.8	497.4	742.1	712.5	715.3	724.4	
7/1/02 16:05	281.9	204.1	286.8	270.0	259.8	373.4	363.8	356.4	368.0	
7/2/02 11:00	190.7	107.5	271.8	258.6	170.7	250.4	245.7	247.1	246.8	
7/3/02 11:05	296.0	170.5	319.3	376.5	255.5	367.0	360.9	343.6	352.4	
7/4/02 11:05	308.5	195.5	379.5	369.8	256.6	371.2	368.0	333.4	360.0	
7/5/02 9:45	315.5	175.2	328.9	296.8	229.0	318.5	310.4	297.4	310.7	
7/6/02 10:40	340.2	186.3	338.6	360.1	247.1	365.7	365.8	352.8	356.4	
7/7/02 10:50	323.1	171.9	362.6	340.2	249.3	339.3	343.2	314.1	332.9	
7/8/02 9:40	332.7	176.1	345.9	316.2	243.9	325.1	318.4	324.9	318.6	
7/9/02 15:30	472.0	280.3	472.6	466.8	287.1	461.5	462.2	454.0	441.6	
7/10/02 9:55	288.0	166.5	283.0	283.8	205.6	276.7	276.5	273.8	270.0	
7/11/02 9:40	375.3	207.0	378.7	375.6	244.9	367.9	367.5	362.0	353.6	
7/12/02 16:20	498.3	253.9	492.2	492.9	323.8	488.5	483.3	477.6	462.0	
7/13/02 10:20	247.9	162.2	281.2	265.4	216.6	270.0	266.2	270.6	261.1	all columns dripping
7/14/02 11:35	398.8	217.9	399.0	399.2	315.4	390.5	388.9	386.9	370.5	
7/15/02 9:35	345.9	142.7	340.1	339.7	265.3	332.9	331.8	323.9	313.0	
7/16/02 10:25	391.3	49.4	392.2	48.9	296.5	381.3	381.0	375.7	362.9	
7/17/02 10:40	382.5	37.8	385.1	377.3	284.2	369.7	368.7	355.2	359.3	
7/18/02 9:55	369.4	76.9	373.1	370.3	277.9	360.7	360.7	354.8	348.8	
7/19/02 9:25	371.1	85.2	369.5	368.4	279.4	359.9	354.7	331.1	341.8	
7/20/02 10:40	403.3	215.0	409.7	406.4	312.5	396.0	392.9	371.0	382.3	
7/21/02 10:40	376.3	294.2	379.8	321.2	291.2	369.1	368.1	372.2	351.4	
7/22/02 8:45	343.2	307.0	350.6	386.3	268.9	332.9	337.5	333.7	324.3	
7/23/02 10:05	397.5	380.5	407.2	408.0	305.5	387.2	392.9	385.2	379.3	
7/24/02 10:50	387.1	373.3	390.8	366.8	300.8	379.1	378.7	368.7	356.2	
7/25/02 10:00	362.9	359.7	369.9	357.9	282.2	357.4	355.1	302.8	344.5	
7/26/02 9:30	370.6	355.8	375.4	383.8	287.4	360.6	363.6	391.8	331.4	
Sums	9684.6	5710.3	10243.6	9745.7	7454.5	10094.6	10019.0	9776.0	9724.2	
Bulk avg. v (cm/day)	3.82	2.25	4.04	3.85	2.94	3.98	3.95	3.86	3.84	
Total time (day)	27.79									

v=ΔW/Antρ

n 0.5 A (cm^2) 182.4

*All sums and averages calculated from 6/30-7/26

Table A-5. Test 1 Daily Effluent Velocity Values.

	Daily Rate (cm/day) (0.3 mL/min equals 4.8 cm/day)									
Day Fraction	1	2	3	4	5	6	7	8	9	
5.06	2.426	0.000	1.492	1.236	2.357	0.055	0.687	0.006	1.808	
1.94	3.468	0.000	2.946	1.177	2.808	0.267	0.006	0.148	2.968	
2.08	3.673	0.000	3.336	0.503	3.539	0.000	0.005	0.376	3.318	
2.02	3.122	0.000	3.028	1.719	3.525	0.000	0.005	0.105	2.932	
2.90	3.007	0.000	2.879	1.279	1.188	0.000	0.004	0.000	3.035	
3.08	3.025	0.000	2.929	0.011	1.452	0.000	0.004	0.222	2.999	all columns not dripping
2.74	1.918	0.000	1.904	0.336	0.619	0.000	1.764	0.941	2.579	
3.27	0.008	0.000	1.359	0.000	0.850	0.001	0.778	0.172	2.028	
3.06	0.241	0.000	0.923	0.001	0.806	0.000	0.010	0.001	3.419	
1.97	2.884	0.000	4.324	2.426	1.603	0.708	3.628	0.267	4.104	
1.74	2.869	0.886	3.964	3.889	2.232	4.000	3.546	2.269	3.941	
0.93	4.953	0.687	8.525	8.432	5.572	8.214	8.190	8.185	8.317	
3.27	2.046	0.497	2.833	2.711	1.789	2.758	2.584	2.697	2.619	
2.06	2.736	1.903	4.041	3.928	2.644	3.945	3.788	3.803	3.851	
1.00	3.091	2.238	3.145	2.961	2.849	4.094	3.989	3.908	4.035	
0.79	2.653	1.495	3.781	3.597	2.375	3.483	3.418	3.438	3.433	
1.00	3.234	1.863	3.489	4.114	2.792	4.010	3.944	3.755	3.851	
1.00	3.383	2.144	4.161	4.055	2.814	4.070	4.035	3.656	3.947	
0.94	3.663	2.034	3.818	3.446	2.659	3.698	3.604	3.453	3.607	
1.04	3.593	1.968	3.576	3.803	2.610	3.862	3.863	3.726	3.764	
1.01	3.518	1.872	3.948	3.705	2.715	3.695	3.737	3.420	3.625	
0.95	3.834	2.030	3.987	3.644	2.811	3.747	3.670	3.745	3.672	
1.24	4.163	2.473	4.169	4.118	2.532	4.071	4.077	4.005	3.895	
0.77	4.115	2.379	4.044	4.055	2.938	3.954	3.951	3.912	3.858	
0.99	4.158	2.294	4.196	4.162	2.714	4.076	4.072	4.011	3.918	
1.28	4.276	2.179	4.224	4.230	2.779	4.192	4.147	4.098	3.965	
0.75	3.624	2.371	4.111	3.880	3.167	3.947	3.892	3.956	3.817	all columns dripping
1.05	4.156	2.271	4.158	4.161	3.287	4.070	4.053	4.032	3.861	
0.92	4.138	1.707	4.068	4.063	3.173	3.982	3.969	3.874	3.744	
1.03	4.147	0.523	4.156	0.518	3.142	4.041	4.037	3.981	3.846	
1.01	4.151	0.410	4.179	4.094	3.084	4.012	4.001	3.855	3.899	
0.97	4.181	0.870	4.223	4.191	3.145	4.083	4.083	4.016	3.948	
0.98	4.156	0.954	4.138	4.125	3.129	4.030	3.972	3.708	3.828	
1.05	4.203	2.241	4.270	4.236	3.257	4.127	4.095	3.867	3.984	
1.00	4.126	3.226	4.164	3.522	3.193	4.047	4.036	4.081	3.853	
0.92	4.090	3.658	4.178	4.603	3.204	3.967	4.022	3.977	3.865	
1.06	4.129	3.953	4.230	4.238	3.173	4.022	4.081	4.001	3.940	
1.03	4.116	3.969	4.155	3.900	3.198	4.031	4.027	3.920	3.787	
0.97	4.122	4.086	4.202	4.066	3.206	4.060	4.034	3.440	3.913	
0.98	4.210	4.042	4.264	4.360	3.265	4.096	4.130	4.451	3.764	
Daily avg v (cm/day)	3.85	2.26	4.04	3.84	2.96	3.98	3.95	3.86	3.83	

Total time (day)
27.79

$v = \Delta W / A n t \rho$

n 0.5 A (cm^2) 182.4

*All sums and averages calculated from 6/30-7/26

Table A-6. Test 1 Port A Data. A) Column 1 (3 pages)

Column # 1 Port A EC (uS/cm) 1760 Br- (mg/L) 522

Date	(Day 1=Start of Tracer Application) Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/24/02	0					0.932	1368.3		0.0018	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	1.060	1360.6	1060	0.0020	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.915	126.2	1050	0.0018	86.36
6/1/02	6	12:00p	6/1/02 12:00	5.90	93.1	1.020	120.9	1110	0.0020	86.36
6/3/02	8	2:10p	6/3/02 14:10	7.99	91.6	135.000	0.0	1170	0.2586	60.96
6/5/02	10	11:15a	6/5/02 11:15	9.86	93.4	373.000	-19.9	1560	0.7146	60.96
6/5/02	10	9:40p	6/5/02 21:40	10.30	93.4	375.000	-20.0	1500	0.7184	60.96
6/6/02	11	2:30p	6/6/02 14:30	11.00	93.1	284.000	-12.8	1440	0.5441	60.96
6/7/02	12	9:40a	6/7/02 9:40	11.80	93.6	175.000	-2.8	1370	0.3352	60.96
6/8/02	13	12:15p	6/8/02 12:15	12.91	93.4	57.000	23.8	1220	0.1092	60.96
6/9/02	14	12:40p	6/9/02 12:40	13.92	93.4	21.100	48.2	1150	0.0404	60.96
6/10/02	15	10:50a	6/10/02 10:50	14.85	93.6	9.660	69.5	1220	0.0185	60.96
6/19/02	24	9:50a	6/19/02 9:50	23.81	91.2	0.572	139.1	1046	0.0011	60.96

B) Column 2

Column # 2 Port A EC (uS/cm) 1760 Br- (mg/L) 525

Date	(Day 1=Start of Tracer Application) Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.860	1370.4		0.0016	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	0.963	1362.9	1100	0.0018	60.96
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	0.893	129.5	1080	0.0017	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.941	125.5	1060	0.0018	60.96
6/1/02	6	1:00p	6/1/02 13:00	5.94	93.1	3.100	94.3	1070	0.0059	60.96
6/3/02	8	2:30p	6/3/02 14:30	8.00	91.6	67.200	17.2	1100	0.1287	60.96
6/4/02	9	12:25p	6/4/02 12:25	8.91	92.7	131.000	0.1	1170	0.2510	60.96
6/5/02	10	11:45a	6/5/02 11:45	9.89	93.4	223.000	-7.3	1250	0.4272	60.96
6/5/02	10	9:40p	6/5/02 21:40	10.30	93.4	333.000		3430 (cloudy)	0.6379	60.96
6/6/02	11	3:00p	6/6/02 15:00	11.02	93.1	197.000	-13.9	1420	0.3774	60.96
6/7/02	12	9:55a	6/7/02 9:55	11.81	93.6	291.000	-13.9	1420	0.5575	60.96
6/8/02	13	12:15p	6/8/02 12:15	12.91	93.4	194.000	-6.3	1420	0.3716	60.96
6/9/02	14	12:45p	6/9/02 12:45	13.93	93.4	136.000	2.5	1320	0.2605	60.96
6/10/02	15	10:55a	6/10/02 10:55	14.85	93.6	74.700	18.8	1350	0.1431	60.96
6/11/02	16	4:05p	6/11/02 16:50	16.10	93.4	20.300	53.2	980	0.0389	60.96
6/12/02	17	4:00p	6/12/02 16:00	17.06	94.8	9.360	74.0	954	0.0179	60.96
6/14/02	19	4:40p	6/14/02 16:40	19.09	92.6	2.300	105.9	969	0.0044	60.96
6/19/02	24	9:30a	6/19/02 9:30	23.79	91.2	0.980	126.1	1080	0.0019	60.96

C) Column 3

Column # 3 Port A EC (uS/cm) 1760 Br- (mg/L) 526

Date	(Day 1=Start of Tracer Application) Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.522	1383.4		0.0010	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	0.855	1365.7	956	0.0016	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.871	127.4	989	0.0017	60.96
6/1/02	6	12:00p	6/1/02 12:00	5.90	93.1	1.190	117.2	1000	0.0023	60.96
6/3/02	8	2:30p	6/3/02 14:30	8.00	91.6	29.900	38.1	1010	0.0573	60.96
6/4/02	9	12:35p	6/4/02 12:35	8.92	92.7	116.000	3.1	1160	0.2222	60.96
6/5/02	10	10:35a	6/5/02 10:35	9.84	93.4	255.000	-10.6	1330	0.4885	60.96
6/5/02	10	9:30p	6/5/02 21:30	10.29	93.4	329.000	-16.8	1410	0.6303	60.96
6/6/02	11	1:50p	6/6/02 13:50	10.97	93.1	348.000	-17.9	1480	0.6667	60.96
6/7/02	12	9:30	6/7/02 9:30	11.79	93.6	301.000	-15.9	1500	0.5766	60.96
6/8/02	13	12:15p	6/8/02 12:15	12.91	93.4	141.000	1.5	1350	0.2701	60.96
6/9/02	14	12:40p	6/9/02 12:40	13.92	93.4	47.100	28.5	1180	0.0902	60.96
6/10/02	15	10:45a	6/10/02 10:45	14.84	93.6	19.500	52.2	1230	0.0374	60.96
6/11/02	16	3:45p	6/11/02 15:45	16.05	93.4	9.780	71.7	917	0.0187	60.96
6/12/02	17	3:40p	6/12/02 15:40	17.05	94.8	6.030	84.9	944	0.0116	60.96
6/14/02	19	4:15p	6/14/02 16:15	19.07	92.6	1.440	116.9	1070	0.0028	60.96
6/19/02	24	9:10a	6/19/02 9:10	23.78	91.2	0.996	126.2	1060	0.0019	60.96

Table A-6. Test 1 Port A Data. D) Column 4 (Continued)

Column # 4 Port A						EC (uS/cm)	1760	Br- (mg/L)	525	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.706	1375.5		0.0013	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	1.070	1360.4	1100	0.0020	60.96
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	1.140		1164	0.0022	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.930	125.8	1040	0.0018	60.96
6/1/02	6	1:15p	6/1/02 13:15	5.95	93.1	0.992	121.6	1060	0.0019	60.96
6/4/02	9	12:25p	6/4/02 12:25	8.91	92.7	1.250	112.9	1080	0.0024	60.96
6/5/02	10	12:05p	6/5/02 12:05	9.90	93.4	3.190	96.5	1090	0.0061	86.36
6/5/02	10	9:55p	6/5/02 21:55	10.31	93.4	4.160	90.1	1140	0.0079	86.36
6/6/02	11	2:05p	6/6/02 14:05	10.98	93.1	12.100	65.7	1110	0.0230	86.36
6/7/02	12	10:15a	6/7/02 10:15	11.82	93.6	86.000	14.7	1130	0.1638	86.36
6/8/02	13	1:00p	6/8/02 13:00	12.94	93.4	326.000	-19.1	1460	0.6210	86.36
6/9/02	14	1:25p	6/9/02 13:25	13.95	93.4	394.000		1550	0.7505	86.36
6/10/02	15	11:10a	6/10/02 11:10	14.86	93.6	395.000	-22.8	1720	0.7524	86.36
6/11/02	16	4:05p	6/11/02 16:05	16.07	93.4	185.000	-2.5	1220	0.3524	86.36
6/12/02	17	4:05p	6/12/02 16:05	17.07	94.8	73.500	21.4	1080	0.1400	86.36
6/14/02	19	4:40p	6/14/02 16:40	19.09	92.6	12.100	65.9	1070	0.0230	86.36
6/19/02	24	10:00a	6/19/02 10:00	23.81	91.2	1.090	124.1	1030	0.0021	86.36

E) Column 5

Column # 5 Port A						EC (uS/cm)	1750	Br- (mg/L)	540	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/24/02	0				98.8	0.939	136801		0.0018	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	1.8	1348.3	1060	0.0034	60.96
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	1.49		1045	0.0028	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.902	126.5	1070	0.0017	86.36
6/1/02	6	12:00p	6/1/02 12:00	5.90	93.1	0.992	121.6	1070	0.0019	86.36
6/3/02	8	2:00p	6/3/02 14:00	7.98	91.6	1.43	112.5	1070	0.0027	86.36
6/4/02	9	12:50p	6/4/02 12:50	8.93	92.7	1.270	112.6	1060	0.0024	86.36
6/5/02	10	10:10p	6/5/02 22:10	10.32	93.4	5.040	85.5	1030	0.0096	86.36
6/6/02	11	3:00p	6/6/02 15:00	11.02	93.1	19.300	54.1	1040	0.0368	86.36
6/7/02	12	10:00a	6/7/02 10:00	11.81	93.6	105.000	9.9	1140	0.2000	86.36
6/8/02	13	12:30p	6/8/02 12:30	12.92	93.4	311.000	-18.1	1440	0.5924	86.36
6/9/02	14	1:05p	6/9/02 13:05	13.94	93.4	451.000	-27.1	1570	0.8590	86.36
6/10/02	15	10:55a	6/10/02 10:55	14.85	93.6	379.000	-21.8	1660	0.7219	86.36
6/11/02	16	3:40p	6/11/02 15:40	16.05	93.4	166.000	0.3	1240	0.3162	86.36
6/12/02	17	3:40p	6/12/02 15:40	17.05	94.8	74.500	21.0	1070	0.1419	86.36
6/14/02	19	4:25p	6/14/02 16:25	19.08	92.600	11.900	66.1	1120	0.0227	86.36

F) Column 6

Column # 6 Port A						EC (uS/cm)	1750	Br- (mg/L)	537	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.764	1373.5		0.0015	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	1.06	1360.7	1010	0.0020	60.96
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	0.954	127.9	1080	0.0018	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.911	126.3	1000	0.0017	60.96
6/2/02	7	12:45p	6/2/02 12:45	6.93	93.1	16.9	53.1	1080	0.0322	60.96
6/3/02	8	2:45p	6/3/02 14:45	8.01	91.6	82.4	12.1	1070	0.1570	60.96
6/4/02	9	12:15p	6/4/02 12:15	8.91	92.7	213.000	-12.1	1270	0.4057	60.96
6/5/02	10	11:10a	6/5/02 11:10	9.86	93.4	322.000	-16.3	1450	0.6133	60.96
6/5/02	10	10:00p	6/5/02 22:00	10.31	93.4	354.000	-18.6	1470	0.6743	60.96
6/6/02	11	2:00p	6/6/02 14:00	10.98	93.1	328.000	-16.4	1440	0.6248	60.96
6/7/02	12	9:55a	6/7/02 9:55	11.81	93.6	256.000	-12.0	1380	0.4876	60.96
6/8/02	13	12:45p	6/8/02 12:45	12.93	93.4	174.000	-3.7	1270	0.3314	60.96
6/9/02	14	1:25p	6/9/02 13:25	13.95	93.4	86.000	13.7	1230	0.1638	60.96
6/10/02	15	11:20a	6/10/02 11:20	14.87	93.6	47.200		1070	0.0899	60.96

Table A-6. Test 1 Port A Data. G) Column 7 (Continued)

Column # 7 Port A						EC (uS/cm)	1750	Br- (mg/L)	535	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/27/02	1	12:00p	5/27/02 12:00	0.90	95.3	1.24	1356	974	0.0023	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	1.25	1356.8	949	0.0023	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.965	124.9	1040	0.0018	86.36
6/1/02	6	12:30p	6/1/02 12:30	5.92	93.1	1.17	117.6	1050	0.0022	86.36
6/3/02	8	1:50p	6/3/02 13:50	7.97	91.6	1.49	111.6	1020	0.0028	86.36
6/4/02	9	12:50p	6/4/02 12:50	8.93	92.7	1.530	108.0	1060	0.0029	86.36
6/5/02	10	10:50a	6/5/02 10:50	9.85	93.4	3.080	97.3	1070	0.0058	86.36
6/5/02	10	9:15p	6/5/02 21:15	10.28	93.4	6.420	79.7	1090	0.0120	86.36
6/6/02	11	2:10p	6/6/02 14:10	10.99	93.1	21.300	51.6	1050	0.0398	86.36
6/7/02	12	10:05a	6/7/02 10:05	11.82	93.6	63.400	22.3	1100	0.1185	86.36
6/8/02	13	12:30p	6/8/02 12:30	12.92	93.4	172.000	-3.4	1210	0.3215	86.36
6/9/02	14	1:20p	6/9/02 13:20	13.95	93.4	281.000	-15.5	1360	0.5252	86.36
6/10/02	15	11:00a	6/10/02 11:00	14.85	93.6	343.000	-19.3	1580	0.6411	86.36
6/11/02	16	3:50p	6/11/02 15:50	16.06	93.4	318.000	-16.1	1310	0.5944	86.36
6/12/02	17	3:45p	6/12/02 15:45	17.05	94.8	238.000	-7.7	1180	0.4449	86.36
6/14/02	19	4:30p	6/14/02 16:30	19.08	92.6	27.800	45.0	1130	0.0520	86.36
6/19/02	24	9:00a	6/19/02 9:00	23.77	91.2	1.820	111.9	1060	0.0034	86.36

H) Column 8

Column # 8 Port A						EC (uS/cm)	1750	Br- (mg/L)	546	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/24/02	0				98.8	0.917	1368.7		0.0017	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	1.020	1361.6	1050	0.0019	60.96
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	0.985	127.1	1020	0.0018	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.934	125.7	1050	0.0017	60.96
6/1/02	6	12:30p	6/1/02 12:30	5.92	93.1	1.790	107.4	1060	0.0033	60.96
6/3/02	8	1:30p	6/3/02 13:30	7.96	91.6	212.000	-11.2	1290	0.3963	60.96
6/4/02	9	12:45p	6/4/02 12:45	8.93	92.7	373.000	-25.9	1510	0.6972	60.96
6/5/02	10	10:25a	6/5/02 10:25	9.83	93.4	464.000	-25.2	1670	0.8673	60.96
6/6/02	11	2:45p	6/6/02 14:45	11.01	93.1	315.000		1400	0.5888	60.96

I) Column 9

Column # 9 Port A						EC (uS/cm)	1760	Br- (mg/L)	544	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.758	1373.7		0.0014	60.96
5/27/02	1	8:00p	5/27/02 20:00	1.23	90.7	0.958	1363.0	1030	0.0018	60.96
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	0.930	128.5	1040	0.0017	60.96
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	1.126		1132	0.0021	86.36
6/2/02	7	12:45p	6/2/02 12:45	6.93	93.1	1.090	119.3	1080	0.0020	86.36
6/3/02	8	2:40p	6/3/02 14:40	8.01	91.6	1.490	111.6	1030	0.0027	86.36
6/4/02	9	12:35p	6/4/02 12:35	8.92	92.7	1.590	107.2	1080	0.0029	86.36
6/5/02	10	10:35a	6/5/02 10:35	9.84	93.4	4.540	88.0	1060	0.0083	86.36
6/5/02	10	9:20p	6/5/02 21:20	10.28	93.4	7.870	74.8	1150	0.0145	86.36
6/6/02	11	2:15p	6/6/02 14:15	10.99	93.1	18.800	54.7	1020	0.0346	86.36
6/7/02	12	10:15a	6/7/02 10:15	11.82	93.6	58.600	24.3	1100	0.1077	86.36
6/8/02	13	12:45p	6/8/02 12:45	12.93	93.4	165.000	-2.3	1210	0.3033	86.36
6/9/02	14	1:05p	6/9/02 13:05	13.94	93.4	278.000	-15.2	1310	0.5110	86.36
6/10/02	15	11:10a	6/10/02 11:10	14.86	93.6	330.000	-18.4	1540	0.6066	86.36
6/11/02	16	4:05p	6/11/02 16:05	16.07	93.4	275.000	-12.5	1220	0.5055	86.36
6/12/02	17	3:50p	6/12/02 15:50	17.06	94.8	202.000	-3.6	1160	0.3713	86.36
6/14/02	19	4:35p	6/14/02 16:35	19.09	92.6	42.300	34.6	1130	0.0778	86.36

Table A-7. Test 1 Port B Data. A) Column 1 (3 pages)

Column # 1 Port B — EC (uS/cm) 1760 — Br- (mg/L) 522

(Day 1=Start of Tracer Application)

Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/24/02	0					0.824	1371.5		0.0016	121.92
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	0.980	127.7	1060	0.0019	121.92
5/31/02	5	1:15p	5/31/02 13:15	4.95	95.8	1.110	124.9	1040	0.0021	121.92
6/6/02	11	9:45a	6/6/02 9:45	10.80	93.1	1.530	115.4	1090	0.0029	121.92
6/11/02	16	2:55p	6/11/02 14:55	16.02	93.4	42.600	34.4	1010	0.0816	121.92
6/12/02	17	10:05a	6/12/02 10:05	16.82	93.4	92.100	14.9	1080	0.1764	121.92
6/13/02	18	2:00p	6/13/02 14:00	17.98	94.8	175.000	0.0	1130	0.3352	121.92
6/14/02	19	9:15a	6/14/02 9:15	18.78	92.6	308.000	-15.6	1340	0.5900	121.92
6/15/02	20	2:00p	6/15/02 14:00	19.98	92.6	286.000	-13.7	1410	0.5479	121.92
6/16/02	21	4:45p	6/16/02 16:45	21.09	91.9	229.000	-9.3	1400	0.4387	121.92
6/17/02	22	8:45a	6/17/02 8:45	21.76	91.9	225.000	-8.8	1380	0.4310	121.92
6/18/02	23	9:05a	6/18/02 9:05	22.77	92.6	187.000	-2.7	1420	0.3582	121.92
6/19/02	24	9:20a	6/19/02 9:20	23.78	91.2	142.000	4.9	1320	0.2720	121.92
6/20/02	25	8:40a	6/20/02 8:40	24.76	91.7	96.400	13.8	1130	0.1847	121.92

B) Column 2

Column # 2 Port B — EC (uS/cm) 1760 — Br- (mg/L) 525

(Day 1=Start of Tracer Application)

Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.866	1370.2		0.0017	121.92
5/31/02	5	1:45p	5/31/02 13:45	4.97	95.8	0.980	128	1000	0.0019	121.92
6/11/02	16	3:30p	6/11/02 15:30	16.04	93.4	2.620		433	0.0050	121.92
6/12/02	17	10:30a	6/12/02 10:30	16.83	93.4	1.620	115.2	908	0.0031	121.92
6/13/02	18	2:35p	6/13/02 14:35	18.00	94.8	2.190		890	0.0042	121.92
6/14/02	19	4:00p	6/14/02 16:00	19.06	92.6	1.010	125.4	1050	0.0019	121.92
6/15/02	20	2:45p	6/15/02 14:45	20.01	92.6	0.855	129.3	1000	0.0016	121.92
6/16/02	21	5:15p	6/16/02 17:15	21.11	91.9	0.934	125.8	995	0.0018	121.92
6/17/02	22	8:45a	6/17/02 8:45	21.76	91.9	1.040	123.0	1040	0.0020	121.92
6/18/02	23	10:05a	6/18/02 10:05	22.82	92.6	7.260	79.8	1060	0.0139	121.92

*No peak recorded

C) Column 3

Column # 3 Port B — EC (uS/cm) 1760 — Br- (mg/L) 526

(Day 1=Start of Tracer Application)

Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/27/02	1	12:00p	5/27/02 12:00	0.90	95.3	0.850	1365.3	849	0.0016	121.92
5/31/02	5	12:00p	5/31/02 12:00	4.90	95.8	0.642	138.5	796	0.0012	121.92
6/6/02	11	9:55a	6/6/02 21:55	11.31	93.1	1.010	125.5	826	0.0019	121.92
6/11/02	16	2:05p	6/11/02 14:05	15.98	93.4	12.100	66.5	912	0.0232	121.92
6/12/02	17	10:00a	6/12/02 10:00	16.81	93.4	23.100	50.3	935	0.0443	121.92
6/13/02	18	1:45p	6/13/02 13:45	17.97	94.8	48.7	31.900	966.0	0.0933	121.92
6/14/02	19	9:15a	6/14/02 9:15	18.78	92.6	104.000	12.0	1150	0.1992	121.92
6/15/02	20	2:00p	6/15/02 14:00	19.98	92.6	167.000	0.1	1210	0.3199	121.92
6/16/02	21	4:50p	6/16/02 16:50	21.10	93.3	195.000	-3.9	1270	0.3736	121.92
6/17/02	22	8:45a	6/17/02 8:45	21.76	93.3	219.000	-6.8	1310	0.4195	121.92
6/18/02	23	8:55a	6/18/02 8:55	22.77	92.6	206.000	-5.0	1340	0.3946	121.92
6/19/02	24	10:20a	6/19/02 10:20	23.83	91.2	157.000	2.4	1240	0.3008	121.92

Table A-7. Test 1 Port B Data. D) Column 4 (Continued)

Column # 4 Port B						EC (uS/cm)	1760	Br- (mg/L)	525	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/27/02	1	12:00p	5/27/02 12:00	0.90	95.3	0.847	1365.4	968	0.0016	121.92
5/31/02	5	1:45p	5/31/02 13:45	4.97	95.8	0.941	129	1020	0.0018	177.8
6/6/02	11	10:00a	6/6/02 10:00	10.81	93.1	1.690	113.1	959	0.0032	177.8
6/11/02	16	3:35p	6/11/02 15:35	16.05	93.4	3.130		242	0.0060	177.8
6/13/02	18	2:30p	6/13/02 14:30	18.00	94.8	1.960	112.2	937	0.0037	177.8
6/14/02	19	4:15p	6/14/02 16:15	19.07	92.6	3.510	95.6	1080	0.0067	121.92
6/15/02	20	2:40p	6/15/02 14:40	20.01	92.6	46.900	32.0	1110	0.0893	121.92
6/16/02	21	5:25p	6/16/02 17:25	21.12	93.3	102.000	12.3	1170	0.1943	121.92
6/17/02	22	3:40p	6/17/02 15:40	22.05	93.3	181.000	-2.1	1260	0.3448	121.92
6/18/02	23	10:50a	6/18/02 10:50	22.85	92.6	218.000	-6.5	1230	0.4152	121.92
6/19/02	24	11:30a	6/19/02 11:30	23.88	91.2	222.000	-6.3	1390	0.4229	121.92
6/20/02	25	9:20a	6/20/02 9:20	24.78	91.7	121.000	8.0	1110	0.2305	121.92

E) Column 5

Column # 5 Port B						EC (uS/cm)	1750	Br- (mg/L)	540	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/27/02	1	12:00p			95.3	0.958	1362.4	739	0.0018	121.92
5/31/02	5	12:00p	5/31/02 12:00	4.90	95.8	0.969	128.3	846	0.0018	177.8
6/6/02	11	9:20a	6/6/02 9:20	10.78	93.1	1.660	113.5	879	0.0032	177.8
6/11/02	16	2:05p	6/11/02 14:05	15.98	93.4	2.370	106.1	888	0.0045	177.8
6/12/02	17	10:00a	6/12/02 10:00	16.81	93.4	2.060	109.5	855	0.0039	177.8
6/13/02	18	1:45p	6/13/02 13:45	17.97	94.8	2.240	109.8	883	0.0043	121.92
6/14/02	19	9:50a	6/14/02 9:50	18.81	92.6	1.280	119.4	1030	0.0024	121.92
6/16/02	21	5:05p	6/16/02 17:05	21.11	93.3	7.870	74.1	1050	0.0150	121.92
6/17/02	22	8:55a	6/17/02 8:55	21.77	93.3	19.900	51.8	1090	0.0379	121.92
6/18/02	23	11:15a	6/18/02 11:15	22.86	92.6	92.300	15.2	1160	0.1758	121.92
6/19/02	24	10:25a	6/19/02 10:25	23.83	91.2	211.000	-5.0	1280	0.4019	121.92

*No peak recorded

F) Column 6

Column # 6 Port B						EC (uS/cm)	1750	Br- (mg/L)	537	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.828	1371.4		0.0016	121.92
5/31/02	5	1:45p	5/31/02 13:45	4.97	95.8	1.02	127	1030	0.0019	121.92
6/6/02	11	10:10a	6/6/02 10:10	10.82	93.1	1.700	112.8	1020	0.0032	121.92
6/11/02	16	2:30p	6/11/02 14:30	16.00	93.4	20.600	52.9	978	0.0392	121.92
6/12/02	17	10:30a	6/12/02 10:30	16.83	93.4	36.200	38.5	960	0.0690	121.92
6/13/02	18	2:10p	6/13/02 14:10	17.99	90.2	57.000	26.1	1030	0.1086	121.92
6/14/02	19	4:00p	6/14/02 16:00	19.06	92.6	94.600		1080	0.1802	121.92
6/15/02	20	4:25p	6/15/02 16:25	20.08	92.6	167.000	0.0	1250	0.3181	121.92
6/16/02	21	5:30p	6/16/02 17:30	21.13	93.3	211.000	-5.9	1270	0.4019	121.92
6/17/02	22	3:00p	6/17/02 15:00	22.02	93.3	246.000	-9.7	1350	0.4686	121.92
6/18/02	23	11:00a	6/18/02 11:00	22.85	92.6	231.000	-7.9	1340	0.4400	121.92
6/19/02	24	11:40a	6/19/02 11:40	23.88	91.2	153.000	3.0	1240	0.2914	121.92

Table A-7. Test 1 Port B Data. G) Column 7 (Continued)

Column # 7 Port B						EC (uS/cm)	1750	Br- (mg/L)	535	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0				98.8	0.751	1373.9		0.0014	121.92
5/31/02	5	12:00p	5/31/02 12:00	4.90	95.8	0.989	127.8	990	0.0018	177.8
6/6/02	11	9:20a	6/6/02 9:20	10.78	93.1	2.060	106.1	1010	0.0039	177.8
6/11/02	16	2:15p	6/11/02 14:15	15.99	93.4	3.440	97.2	858	0.0064	177.8
6/12/02	17	10:05a	6/12/02 10:05	16.82	93.4	2.400	105.8	858	0.0045	177.8
6/13/02	18	1:55p	6/13/02 13:55	17.98	90.2	2.300	104.9	869	0.0043	177.8
6/14/02	19	9:50a	6/14/02 9:50	18.81	92.6	1.210	121.1	1020	0.0023	121.92
6/15/02	20	2:30p	6/15/02 14:30	20.00	92.6	3.110	98.9	962	0.0058	121.92
6/16/02	21	5:10p	6/16/02 17:10	21.11	93.3	28.000	43.6	1050	0.0523	121.92
6/17/02	22	3:15p	6/17/02 15:15	22.03	93.3	143.000	4.0	1160	0.2673	121.92
6/18/02	23	11:15a	6/18/02 11:15	22.86	92.6	235.000	-8.3	1340	0.4393	121.92

*No peak recorded

H) Column 8

Column # 8 Port B						EC (uS/cm)	1750	Br- (mg/L)	546	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/23/02	0			0.00	98.8	0.686	1376.3		0.0013	121.92
5/31/02	5	11:30a	5/31/02 11:30	4.88	95.8	1.060	126.0	950	0.0020	177.8
6/6/02	11	9:20a	6/6/02 9:20	10.78	93.1	2.730	101.6	1010	0.0051	177.8
6/11/02	16	3:25p	6/11/02 15:25	16.04	93.4	2.220	107.7	898	0.0041	177.8
6/12/02	17	10:10a	6/12/02 10:10	16.82	93.4	2.290	106.9	910	0.0043	177.8
6/13/02	18	2:00p	6/13/02 14:00	17.98	90.2	1.880	109.6	924	0.0035	177.8
6/14/02	19	4:05p	6/14/02 16:05	19.07	92.6	200.000	-4.6	1260	0.3738	121.92
6/15/02	20	2:30p	6/15/02 14:30	20.00	92.6	356.000	-19.3	1430	0.6654	121.92
6/16/02	21	5:00p	6/16/02 17:00	21.10	93.3	336.000	-17.4	1400	0.6280	121.92
6/17/02	22	3:20p	6/17/02 15:20	22.03	93.3	211.000	-6.0	1330	0.3944	121.92

I) Column 9

Column # 9 Port B						EC (uS/cm)	1760	Br- (mg/L)	544	
	(Day 1=Start of Tracer Application)									
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio	Port (cm)
5/24/02	0				98.8	0.828	1371.4		0.0015	121.92
5/31/02	5	11:30a	5/31/02 11:30	4.88	95.8	0.973	128.2	1030	0.0018	121.92
6/6/02	11	10:15a	6/6/02 10:15	10.82	93.1	1.870	110.7	1010	0.0035	121.92
6/11/02	16	2:20p	6/11/02 14:20	15.99	93.4	12.100	66.5	973	0.0226	121.92
6/12/02	17	10:15	6/12/02 10:15	16.82	93.4	24.000	49.0	983	0.0449	121.92
6/13/02	18	2:15p	6/13/02 14:15	17.99	90.2	45.600	31.8	996	0.0852	121.92
6/14/02	19	9:40a	6/14/02 9:40	18.80	92.6	82.200	18.0	1130	0.1536	121.92
6/15/02	20	4:25p	6/15/02 16:25	20.08	92.6	143.0	3.9	1220	0.2673	121.92
6/16/02	21	5:05p	6/16/02 17:05	21.11	93.3	188.000	-3.1	1270	0.3514	121.92
6/17/02	22	2:50p	6/17/02 14:50	22.01	93.3	243.000	-9.4	1330	0.4542	121.92
6/18/02	23	9:20a	6/18/02 9:20	22.78	92.6	245.000	-9.3	1350	0.4579	121.92
6/19/02	24	10:50a	6/19/02 10:50	23.85	91.2	216.000	-5.6	1360	0.4037	121.92
6/20/02	25	9:05a	6/20/02 9:05	24.77	91.7	133.000	5.5	1110	0.2486	121.92

Table A-8. Test 1 Outlet Data. A) Column 1

Column # 1 Outlet			Location (cm)	193.6		EC (uS/cm)	1760	Br- (mg/L)	522
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.805	1372.2		0.0015
5/27/02	1	12:00p	5/27/02 12:00	0.90	95.3	1.730	1347.6	1040	0.0033
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	1.000	124	959	0.0019
6/6/02	11	10:20a	6/6/02 10:20	10.83	93.1	1.250	120.3	1040	0.0024
6/10/02	15	11:25a	6/10/02 11:25	14.87	93.6	1.250	118.8	1150	0.0024
6/13/02	18	2:40p	6/13/02 14:40	18.01	94.8	1.600	117.0	1010	0.0031
6/17/02	22	9:10a	6/17/02 9:10	21.78	91.9	1.010	123.7	1090	0.0019
6/20/02	25	8:40a	6/20/02 8:40	24.76	91.7	1.020	125.5	941	0.0020
6/21/02	26	9:25a	6/21/02 9:25	25.79	91.7	0.963	127.0	973	0.0018
6/22/02	27	9:45a	6/22/02 9:45	26.80	90.6	1.170	120.2	962	0.0022
6/22/02	27	4:35p	6/22/02 16:35	27.09	90.6	1.170	118.7	987	0.0022
6/23/02	28	11:35a	6/23/02 11:35	27.88	90.2	1.200	118.9	1020	0.0023
6/23/02	28	6:10p	6/23/02 18:10	28.15	90.2	1.400	115.2	1000	0.0027
6/24/02	29	8:30a	6/24/02 8:30	28.75	90.6	1.490	115.0	1020	0.0029
6/24/02	29	5:05p	6/24/02 17:05	29.11	90.6	1.950	108.8	1040	0.0037
6/25/02	30	8:00a	6/25/02 8:00	29.73	94.1	2.990	99.5	1070	0.0057
6/25/02	30	10:15p	6/25/02 22:15	30.32	94.1	4.820	88.0	1070	0.0092
6/26/02	31	8:30a	6/26/02 8:30	30.75	90.4	6.430	80.1	883	0.0123
6/26/02	31	4:50p	6/26/02 16:50	31.10	90.4	8.500	73.9	805	0.0163
6/27/02	32	8:50a	6/27/02 8:50	31.76	90.4	15.100	59.5	895	0.0289
6/27/02	32	4:55p	6/27/02 16:55	32.10	90.4	21.400	50.9	907	0.0410
6/28/02	33	8:25a	6/28/02 8:25	32.75	91.1	35.500	37.2	1200	0.0680
6/28/02	33	3:35p	6/28/02 15:35	33.05	91.1	43.500	32.2	1200	0.0833
6/29/02	34	10:20a	6/29/02 10:20	33.83	91.1	63.000	23.0	1210	0.1207
6/29/02	34	6:05p	6/29/02 18:05	34.15	91.1	71.000	20.0	1230	0.1360
6/30/02	35	8:00a	6/30/02 8:00	34.73	94.1	85.000	17.2	1260	0.1628
6/30/02	35	4:30p	6/30/02 16:30	35.08	94.1	91.000	15.4	1260	0.1743
7/1/02	36	6:45a	7/1/02 6:45	35.68	94.1	96.000	14.1	1250	0.1839
7/1/02	36	5:35p	7/1/02 17:35	36.13	94.1	94.900	14.4	1270	0.1818
7/2/02	37	9:30a	7/2/02 9:30	36.79	93.9	85.500	14.4	1220	0.1638
7/2/02	37	5:35p	7/2/02 17:35	37.13	93.9	78.700	16.5	1250	0.1508
7/3/02	38	10:00a	7/3/02 10:00	37.81	93.9	64.300	21.6	1250	0.1232
7/3/02	38	5:30p	7/3/02 17:30	38.13	93.9	55.200	25.4	1250	0.1057
7/4/02	39	11:35a	7/4/02 11:35	38.88	91.9	41.300	39.5	1220	0.0791
7/4/02	39	5:55p	7/4/02 17:55	39.14	91.9	33.500	44.8	1210	0.0642
7/5/02	40	9:25a	7/5/02 9:25	39.79	91.9	18.500	59.8	1170	0.0354
7/5/02	40	7:05p	7/5/02 19:05	40.19	91.9	12.600	69.4	1170	0.0241
7/6/02	41	11:10a	7/6/02 11:10	40.86	97.1	5.770	85.0	1020	0.0111
7/6/02	41	6:40p	7/6/02 18:40	41.17	97.1	4.280	92.5	1050	0.0082
7/7/02	42	11:15a	7/7/02 11:15	41.86	97.1	2.690	104.1	1020	0.0052
7/7/02	42	9:10p	7/7/02 21:10	42.28	97.1	2.090	110.4	1030	0.0040
7/8/02	43	10:10a	7/8/02 10:10	42.82	96.1	1.580	115.4	874	0.0030
7/9/02	44	3:50p	7/9/02 15:50	44.06	96.1	1.170	122.9	855	0.0022
7/10/02	45	10:20a	7/10/02 10:20	44.83	97.1	1.330	121.7	863	0.0025
7/11/02	46	10:10a	7/11/02 10:10	45.82	97.1	1.100	126.4	875	0.0021
7/12/02	47	4:40p	7/12/02 16:40	47.09	97.1	1.290	123.6	862	0.0025
7/13/02	48	10:45a	7/13/02 10:45	47.84	97.1	1.080	128.1	861	0.0021
7/14/02	49	12:05p	7/14/02 12:05	48.90	97.3	1.260	123.4	852	0.0024
7/15/02	50	10:05a	7/15/02 10:05	49.82	97.1	1.160	124.5	853	0.0022
7/16/02	51	10:50a	7/16/02 10:50	50.85	98.2	0.961	132.2	853	0.0018
7/17/02	52	11:05a	7/17/02 11:05	51.86	96.1	0.923	130.3	833	0.0018
7/18/02	53	10:30a	7/18/02 10:30	52.83	94.8	0.934	125.9	839	0.0018
7/19/02	54	9:45a	7/19/02 9:45	53.80	94.8	0.776	130.6	839	0.0015
7/20/02	55	11:05a	7/20/02 11:05	54.86	93.9	0.827	127.7	846	0.0016
7/21/02	56	11:05a	7/21/02 11:05	55.86	93.9	0.735	130.5	848	0.0014
7/22/02	57	9:10a	7/22/02 9:10	56.78	94.6	0.880	128.3	846	0.0017
7/23/02	58	10:45a	7/23/02 10:45	57.84	96.5	0.876	128.3	848	0.0017
7/24/02	59	11:15a	7/24/02 11:15	58.86	97.7	0.871	130.7	845	0.0017
7/25/02	60	10:30a	7/25/02 10:30	59.83	97.5	0.882	129.7	831	0.0017
7/26/02	61	10:00a	7/26/02 10:00	60.81	96.5	0.809	130.0	825	0.0015

(Continued on next page)

Table A-8. Test 1 Outlet Data. B) Column 2 (Continued)

Column # 2 Outlet				Location (cm)	192.1	EC (uS/cm)	1760	Br- (mg/L)	525
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.726	1374.8		0.0014
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.882	127.1	1010	0.0017
6/6/02	11	10:30a	6/6/02 10:30	10.83	93.1	3.940	92.8	1010	0.0075
6/10/02	15	11:40a	6/10/02 11:40	14.88	93.6	1.240	119.1	1110	0.0024
6/13/02	18	2:50p	6/13/02 14:50	18.01	94.8	1.610	117.1	916	0.0031
6/17/02	22	9:10a	6/17/02 9:10	21.78	91.9	0.985	124.5	1000	0.0019
6/20/02	25	5:30p	6/20/02 17:30	25.13	91.7	0.894	128.7	939	0.0017
6/21/02	26	10:20a	6/21/02 10:20	25.83	91.7	0.926	128.3	898	0.0018
6/22/02	27	10:00a	6/22/02 10:00	26.81	90.6	1.100	121.3	882	0.0021
6/22/02	27	4:50p	6/22/02 16:50	27.10	90.6	1.160	120.0	888	0.0022
6/23/02	28	11:50a	6/23/02 11:50	27.89	90.2	1.190	119.0	941	0.0023
6/23/02	28	6:20p	6/23/02 18:20	28.16	90.2	1.190	119.0	940	0.0023
6/24/02	29	8:45a	6/24/02 8:45	28.76	90.6	1.200	120.0	959	0.0023
6/24/02	29	5:20p	6/24/02 17:20	29.12	90.6	1.210	119.9	977	0.0023
6/25/02	30	8:15a	6/25/02 8:15	29.74	94.1	1.390	118.1	977	0.0026
6/25/02	30	10:30p	6/25/02 22:30	30.33	94.1	1.420	117.6	978	0.0027
6/26/02	31	8:50a	6/26/02 8:50	30.76	90.4	1.32	117.2	772	0.0025
6/26/02	31	5:00p	6/26/02 17:00	31.10	90.4	1.31	117.4	802	0.0025
6/27/02	32	9:05a	6/27/02 9:05	31.77	90.4	1.33	117.1	810	0.0025
6/27/02	32	5:10p	6/27/02 17:10	32.11	90.4	1.38	116.3	810	0.0026
6/28/02	33	8:40a	6/28/02 8:40	32.76	91.1	1.460	114.0	1040	0.0028
6/28/02	33	3:50p	6/28/02 15:50	33.06	91.1	1.570	112.3	1040	0.0030
6/29/02	34	10:30a	6/29/02 10:30	33.83	91.1	1.720	110.2	1070	0.0033
6/29/02	34	6:20p	6/29/02 18:20	34.16	91.1	1.780	109.8	1080	0.0034
6/30/02	35	8:10a	6/30/02 8:10	34.74	94.1	1.070	126.8	1040	0.0020
6/30/02	35	4:40p	6/30/02 16:40	35.09	94.1	1.030	128.0	1040	0.0020
7/1/02	36	7:00a	7/1/02 7:00	35.69	94.1	1.200	128.0	1060	0.0023
7/1/02	36	5:45p	7/1/02 17:45	36.14	94.1	1.000	128.4	1060	0.0019
7/2/02	37	9:40a	7/2/02 9:40	36.80	93.9	1.210	121.4	1020	0.0023
7/2/02	37	5:45p	7/2/02 17:45	37.14	93.9	1.160	120.6	1030	0.0022
7/3/02	38	10:15a	7/3/02 10:15	37.82	93.9	1.110	121.6	1030	0.0021
7/3/02	38	5:45p	7/3/02 17:45	38.14	93.9	1.140	121.0	1040	0.0022
7/4/02	39	11:50a	7/4/02 11:50	38.89	91.9	1.140	126.9	1060	0.0022
7/4/02	39	6:10p	7/4/02 18:10	39.15	91.9	1.030	129.2	1060	0.0020
7/5/02	40	9:40a	7/5/02 9:40	39.80	91.9	1.020	129.5	1060	0.0019
7/5/02	40	7:15p	7/5/02 19:15	40.20	91.9	1.030	129.2	1050	0.0020
7/6/02	41	11:20a	7/6/02 11:20	40.87	97.1	1.210	124.0	963	0.0023
7/6/02	41	6:55p	7/6/02 18:55	41.18	97.1	1.160	125.1	960	0.0022
7/7/02	42	11:30a	7/7/02 11:30	41.88	97.1	1.290	122.5	954	0.0025
7/7/02	42	9:20p	7/7/02 21:20	42.28	97.1	1.660	116.1	958	0.0032
7/8/02	43	10:20a	7/8/02 10:20	42.83	96.1	2.400	105.0	860	0.0046
7/9/02	44	4:00p	7/9/02 16:00	44.06	96.1	8.980	72.4	861	0.0171
7/10/02	45	10:30a	7/10/02 10:30	44.83	97.1	18.500	55.7	871	0.0352
7/10/02	45	4:35p	7/10/02 16:35	45.09	97.1	23.500	49.7	878	0.0448
7/11/02	46	10:20a	7/11/02 10:20	45.83	97.1	35.700	39.1	879	0.0680
7/12/02	47	9:30a	7/12/02 9:30	46.79	97.1	49.000	32.4	911	0.0933
7/12/02	47	4:50p	7/12/02 16:50	47.10	97.1	53.000	30.4	915	0.1010
7/13/02	48	10:55a	7/13/02 10:55	47.85	97.1	55.100	29.4	916	0.1050
7/13/02	48	6:50p	7/13/02 18:50	48.18	97.3	47.900	31.9	932	0.0912
7/14/02	49	12:15p	7/14/02 12:15	48.91	97.3	43.500	34.3	932	0.0829
7/14/02	49	6:45p	7/14/02 18:45	49.18	97.1	38.300	36.4	929	0.0730
7/15/02	50	10:15a	7/15/02 10:15	49.82	97.1	33.300	39.9	928	0.0634
7/15/02	50	3:45p	7/15/02 15:45	50.05	98.2	29.400	45.0	927	0.0560
7/16/02	51	11:00a	7/16/02 11:00	50.85	98.2	26.700	47.4	914	0.0509
7/17/02	52	11:15a	7/17/02 11:15	51.86	96.1	23.900	49.3	911	0.0455
7/18/02	53	10:40a	7/18/02 10:40	52.84	94.8	17.300	54.3	896	0.0330
7/18/02	53	4:45p	7/18/02 16:45	53.09	94.8	15.800	56.5	898	0.0301
7/19/02	54	9:55a	7/19/02 9:55	53.81	94.8	12.800	61.6	895	0.0244
7/20/02	55	11:15a	7/20/02 11:15	54.86	93.9	6.340	78.0	886	0.0121
7/20/02	55	6:15p	7/20/02 18:15	55.16	93.9	5.280	82.5	880	0.0101
7/21/02	56	11:15a	7/21/02 11:15	55.86	93.9	2.810	97.8	871	0.0054
7/21/02	56	4:40p	7/21/02 16:40	56.09	94.6	2.120	106.9	845	0.0040
7/22/02	57	9:20a	7/22/02 9:20	56.78	94.6	1.370	117.5	845	0.0026
7/23/02	58	10:55a	7/23/02 10:55	57.85	96.5	0.886	128.0	856	0.0017
7/24/02	59	11:25a	7/24/02 11:25	58.87	97.7	0.866	130.8	828	0.0016
7/25/02	60	10:40a	7/25/02 10:40	59.84	97.5	0.868	130.1	836	0.0017
7/26/02	61	10:10a	7/26/02 10:10	60.82	96.5	0.809	130.0	816	0.0015

Table A-8. Test 1 Outlet Data. C) Column 3 (Continued)

Column # 3 Outlet				Location (cm)	193.5	EC (uS/cm)	1760	Br- (mg/L)	526
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.511	1384		0.0010
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.729	131.7	839	0.0014
6/6/02	11	10:25a	6/6/02 10:25	10.83	93.1	1.140	122.6	815	0.0022
6/10/02	15	11:50a	6/10/02 11:50	14.89	93.6	1.050	123.2	846	0.0020
6/13/02	18	2:45p	6/13/02 14:45	18.01	94.8	1.140	125.5	696	0.0022
6/17/02	22	9:15a	6/17/02 9:15	21.78	93.3	0.664	134.1	770	0.0013
6/20/02	25	9:30a	6/20/02 9:30	24.79	91.7	0.633	136.9	741	0.0012
6/21/02	26	10:00a	6/21/02 10:00	25.81	91.7	0.666	135.7	742	0.0013
6/22/02	27	9:50a	6/22/02 9:50	26.81	90.6	0.850	127.2	741	0.0016
6/22/02	27	4:40p	6/22/02 16:40	27.09	90.6	0.862	126.9	748	0.0016
6/23/02	28	11:45a	6/23/02 11:45	27.89	90.2	1.100	120.7	834	0.0021
6/23/02	28	6:15p	6/23/02 18:15	28.16	90.2	1.320	116.6	837	0.0025
6/24/02	29	8:35a	6/24/02 8:35	28.75	90.6	2.110	106.8	872	0.0040
6/24/02	29	5:15p	6/24/02 17:15	29.11	90.6	3.270	96.6	881	0.0062
6/25/02	30	8:05a	6/25/02 8:05	29.73	94.1	6.000	82.7	926	0.0114
6/25/02	30	10:20p	6/25/02 22:20	30.33	94.1	13.200	63.2	932	0.0251
6/26/02	31	8:35a	6/26/02 8:35	30.75	90.4	20.500	52.0	788	0.0390
6/26/02	31	4:55p	6/26/02 16:55	31.10	90.4	31.600	41.2	803	0.0601
6/27/02	32	8:55a	6/27/02 8:55	31.77	90.4	61.000	24.8	832	0.1160
6/27/02	32	5:00p	6/27/02 17:00	32.10	90.4	78.000	18.6	861	0.1483
6/28/02	33	8:30a	6/28/02 8:30	32.75	91.1	110.000	9.2	1160	0.2091
6/28/02	33	3:40p	6/28/02 15:40	33.05	91.1	120.000	7.1	1190	0.2281
6/29/02	34	10:25a	6/29/02 10:25	33.83	91.1	129.000	5.4	1230	0.2452
6/29/02	34	6:10p	6/29/02 18:10	34.15	91.1	123.000	6.5	1260	0.2338
6/30/02	35	8:05a	6/30/02 8:05	34.73	94.1	106.000	11.5	1240	0.2015
6/30/02	35	4:35p	6/30/02 16:35	35.09	94.1	91.400	15.3	1230	0.1738
7/1/02	36	6:50a	7/1/02 6:50	35.68	94.1	62.000	25.3	1200	0.1179
7/1/02	36	5:40p	7/1/02 17:40	36.13	94.1	43.500	34.4	1200	0.0827
7/2/02	37	9:35a	7/2/02 9:35	36.80	93.9	21.900	48.6	1110	0.0416
7/2/02	37	5:40p	7/2/02 17:40	37.13	93.9	15.900	56.7	1130	0.0302
7/3/02	38	10:10a	7/3/02 10:10	37.82	93.9	8.600	72.1	1140	0.0163
7/3/02	38	5:35p	7/3/02 17:35	38.13	93.9	6.200	80.1	1150	0.0118
7/4/02	39	11:40a	7/4/02 11:40	38.88	91.9	3.290	101.8	1050	0.0063
7/4/02	39	6:00p	7/4/02 18:00	39.15	91.9	3.000	104.0	1080	0.0057
7/5/02	40	9:30a	7/5/02 9:30	39.79	91.9	2.220	111.2	1110	0.0042
7/5/02	40	7:10p	7/5/02 19:10	40.19	91.9	1.910	114.7	1120	0.0036
7/6/02	41	11:15a	7/6/02 11:15	40.86	97.1	1.590	117.2	975	0.0030
7/6/02	41	6:50p	7/6/02 18:50	41.18	97.1	1.400	120.3	983	0.0027
7/7/02	42	11:25a	7/7/02 11:25	41.87	97.1	1.290	122.4	986	0.0025
7/7/02	42	9:15p	7/7/02 21:15	42.28	97.1	1.240	123.5	988	0.0024
7/8/02	43	10:15a	7/8/02 10:15	42.82	96.1	1.270	120.9	870	0.0024
7/9/02	44	4:05p	7/9/02 16:05	44.07	96.1	1.120	123.9	871	0.0021
7/10/02	45	10:30a	7/10/02 10:30	44.83	97.1	1.500	118.6	870	0.0029
7/11/02	46	10:20a	7/11/02 10:20	45.83	97.1	1.200	124.2	873	0.0023
7/12/02	47	4:50p	7/12/02 16:50	47.10	97.1	1.300	123.5	855	0.0025
7/13/02	48	10:55a	7/13/02 10:55	47.85	97.1	1.150	126.5	850	0.0022
7/14/02	49	12:15p	7/14/02 12:15	48.91	97.3	1.320	122.2	840	0.0025
7/15/02	50	10:15a	7/15/02 10:15	49.82	97.1	1.100	125.7	845	0.0021
7/16/02	51	11:00a	7/16/02 11:00	50.85	98.2	0.987	131.5	829	0.0019
7/17/02	52	11:20a	7/17/02 11:20	51.87	96.1	0.971	129.0	820	0.0018
7/18/02	53	10:40a	7/18/02 10:40	52.84	94.8	0.905	126.8	826	0.0017
7/19/02	54	9:55a	7/19/02 9:55	53.81	94.8	0.827	129.1	820	0.0016
7/20/02	55	11:15a	7/20/02 11:15	54.86	93.9	0.882	126.1	831	0.0017
7/21/02	56	11:20a	7/21/02 11:20	55.87	93.9	0.791	128.8	833	0.0015
7/22/02	57	9:20a	7/22/02 9:20	56.78	94.6	0.911	127.5	836	0.0017
7/23/02	58	10:55a	7/23/02 10:55	57.85	96.5	0.837	129.4	841	0.0016
7/24/02	59	11:25a	7/24/02 11:25	58.87	97.7	0.871	130.7	841	0.0017
7/25/02	60	10:40a	7/25/02 10:40	59.84	97.5	0.837	131.0	837	0.0016
7/26/02	61	10:10a	7/26/02 10:10	60.82	96.5	0.767	131.3	823	0.0015

Table A-8. Test 1 Outlet Data. D) Column 4 (Continued)

Column # 4 Outlet				Location (cm)	192.2	EC (uS/cm)	1760	Br- (mg/L)	525
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.828	1371.4	821	0.0016
5/27/02	1	12:00p	5/27/02 12:00	0.90	95.3	0.920	1363.4	1020	0.0018
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.769	130.4	1010	0.0015
6/6/02	11	10:25a	6/6/02 10:25	10.83	93.1	1.360	118.3	1010	0.0026
6/10/02	15	11:30	6/10/02 11:30	14.88	93.6	1.750	110.6	1120	0.0033
6/13/02	18	2:45p	6/13/02 14:45	18.01	94.8	1.590	117.4	949	0.0030
6/17/02	22	9:20a	6/17/02 9:20	21.78	93.3	1.140	121.0	1020	0.0022
6/20/02	25	5:25p	6/20/02 17:25	25.12	91.7	1.180	122.1	981	0.0022
6/21/02	26	10:15a	6/21/02 10:15	25.82	91.7	1.180	122.2	980	0.0022
6/22/02	27	9:55a	6/22/02 9:55	26.81	90.6	1.330	116.8	936	0.0025
6/22/02	27	4:45p	6/22/02 16:45	27.09	90.6	1.550	113.2	959	0.0030
6/23/02	28	11:50a	6/23/02 11:50	27.89	90.2	2.700	99.9	970	0.0051
6/23/02	28	6:20p	6/23/02 18:20	28.16	90.2	3.270	95.5	988	0.0062
6/24/02	29	8:40a	6/24/02 8:40	28.76	90.6	6.460	80.9	1020	0.0123
6/24/02	29	5:20p	6/24/02 17:20	29.12	90.6	9.420	71.6	1050	0.0179
6/25/02	30	8:10a	6/25/02 8:10	29.74	94.1	14.700	60.5	1060	0.0280
6/25/02	30	10:25p	6/25/02 22:25	30.33	94.1	24.700	47.5	1060	0.0470
6/26/02	31	8:45a	6/26/02 8:45	30.76	90.4	31.300	41.4	886	0.0596
6/26/02	31	5:00p	6/26/02 17:00	31.10	90.4	40.300	35.1	808	0.0768
6/27/02	32	9:00a	6/27/02 9:00	31.77	90.4	56.200	26.8	813	0.1070
6/27/02	32	5:05p	6/27/02 17:05	32.11	90.4	63.400	23.8	924	0.1208
6/28/02	33	8:35a	6/28/02 8:35	32.75	91.1	70.600	20.1	1190	0.1345
6/28/02	33	3:45p	6/28/02 15:45	33.05	91.1	74.500	18.8	1180	0.1419
6/29/02	34	10:30a	6/29/02 10:30	33.83	91.1	74.800	18.7	1240	0.1425
6/29/02	34	6:15p	6/29/02 18:15	34.16	91.1	72.600	19.4	1260	0.1383
6/30/02	35	8:10a	6/30/02 8:10	34.74	94.1	65.900	23.7	1220	0.1255
6/30/02	35	4:40p	6/30/02 16:40	35.09	94.1	60.300	26.0	1190	0.1149
7/1/02	36	6:55a	7/1/02 6:55	35.68	94.1	48.700	31.5	1190	0.0928
7/1/02	36	5:40p	7/1/02 17:40	36.13	94.1	40.900	36.0	1210	0.0779
7/2/02	37	9:40a	7/2/02 9:40	36.80	93.9	30.000	40.7	1120	0.0571
7/2/02	37	5:40p	7/2/02 17:40	37.13	93.9	25.100	45.2	1140	0.0478
7/3/02	38	10:10a	7/3/02 10:10	37.82	93.9	20.500	50.3	1180	0.0390
7/3/02	38	5:40p	7/3/02 17:40	38.13	93.9	19.100	52.1	1180	0.0364
7/4/02	39	11:45a	7/4/02 11:45	38.89	91.9	15.000	65.0	1120	0.0286
7/4/02	39	6:05p	7/4/02 18:05	39.15	91.9	13.500	67.7	1110	0.0257
7/5/02	40	9:35a	7/5/02 9:35	39.80	91.9	13.600	67.4	1130	0.0259
7/5/02	40	7:15p	7/5/02 19:15	40.20	91.9	12.300	70.0	1130	0.0234
7/6/02	41	11:20a	7/6/02 11:20	40.87	97.1	7.170	79.6	1020	0.0137
7/6/02	41	6:55p	7/6/02 18:55	41.18	97.1	6.490	82.1	1010	0.0124
7/7/02	42	11:25a	7/7/02 11:25	41.87	97.1	5.250	87.4	1000	0.0100
7/7/02	42	9:15p	7/7/02 21:15	42.28	97.1	4.560	90.9	1010	0.0087
7/8/02	43	10:20a	7/8/02 10:20	42.83	96.1	3.080	98.8	879	0.0059
7/9/02	44	4:00p	7/9/02 16:00	44.06	96.1	2.290	106.2	866	0.0044
7/10/02	45	10:25a	7/10/02 10:25	44.83	97.1	1.620	116.7	855	0.0031
7/11/02	46	10:15a	7/11/02 10:15	45.82	97.1	1.440	119.7	870	0.0027
7/12/02	47	4:45p	7/12/02 16:45	47.09	97.1	1.210	125.2	835	0.0023
7/13/02	48	10:50a	7/13/02 10:50	47.85	97.1	1.290	123.7	887	0.0025
7/14/02	49	12:15p	7/14/02 12:15	48.91	97.3	1.140	125.8	847	0.0022
7/15/02	50	10:10a	7/15/02 10:10	49.82	97.1	0.973	128.8	844	0.0019
7/16/02	51	10:55a	7/16/02 10:55	50.85	98.2	0.930	133.0	845	0.0018
7/17/02	52	11:15a	7/17/02 11:15	51.86	96.1	0.923	130.3	821	0.0018
7/18/02	53	10:40a	7/18/02 10:40	52.84	94.8	0.818	129.3	821	0.0016
7/19/02	54	9:55a	7/19/02 9:55	53.81	94.8	0.799	129.9	821	0.0015
7/20/02	55	11:15a	7/20/02 11:15	54.86	93.9	0.758	129.8	839	0.0014
7/21/02	56	11:15a	7/21/02 11:15	55.86	94.6	0.834	129.7	786	0.0016
7/22/02	57	9:15a	7/22/02 9:15	56.78	94.6	0.817	130.2	838	0.0016
7/23/02	58	10:55a	7/23/02 10:55	57.85	96.5	0.815	130.1	836	0.0016
7/24/02	59	11:20a	7/24/02 11:20	58.87	97.7	0.865	130.9	842	0.0016
7/25/02	60	10:35a	7/25/02 10:35	59.84	97.5	0.828	131.3	837	0.0016
7/26/02	61	10:10a	7/26/02 10:10	60.82	96.5	0.779	130.9	818	0.0015

Table A-8. Test 1 Outlet Data. E) Column 5 (Continued)

Column # 5 Outlet				Location (cm)	194.2	EC (uS/cm)	1750	Br- (mg/L)	540
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.598	1379.9		0.0011
5/27/02	1	12:00p	5/27/02 12:00	0.90	95.3	1.04	1360.3	743	0.0019
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.92	126.1	806	0.0017
6/6/02	11	10:20a	6/6/02 10:20	10.83	93.1	2.020	108.8	906	0.0037
6/10/02	15	11:25a	6/10/02 11:25	14.87	93.6	2.250	104.7	1030	0.0042
6/13/02	18	2:40p	6/13/02 14:40	18.01	94.8	2.010	111.6	864	0.0037
6/17/02	22	9:10a	6/17/02 9:10	21.78	93.3	1.230	119.3	943	0.0023
6/20/02	25	9:25a	6/20/02 9:25	24.79	91.7	1.290	120.0	896	0.0024
6/21/02	26	9:55a	6/21/02 9:55	25.81	91.7	1.280	120.2	900	0.0024
6/22/02	27	9:45a	6/22/02 9:45	26.80	90.6	1.330	116.7	868	0.0025
6/22/02	27	4:35p	6/22/02 16:35	27.09	90.6	1.320	116.9	847	0.0024
6/23/02	28	11:35a	6/23/02 11:35	27.88	90.2	1.500	113.5	934	0.0028
6/23/02	28	6:10p	6/23/02 18:10	28.15	90.2	1.490	113.7	940	0.0028
6/24/02	29	8:30a	6/24/02 8:30	28.75	90.6	1.570	113.7	951	0.0029
6/24/02	29	5:10p	6/24/02 17:10	29.11	90.6	1.440	115.7	954	0.0027
6/25/02	30	8:00a	6/25/02 8:00	29.73	94.1	1.680	113.5	955	0.0031
6/25/02	30	10:15p	6/25/02 22:15	30.32	94.1	1.780	112.1	956	0.0033
6/26/02	31	8:30a	6/26/02 8:30	30.75	90.4	1.930	108.4	795	0.0036
6/26/02	31	5:50p	6/26/02 17:50	31.14	90.4	1.950	108.2	801	0.0036
6/27/02	32	8:50a	6/27/02 8:50	31.76	90.4	1.810	109.9	760	0.0034
6/27/02	32	4:55p	6/27/02 16:55	32.10	90.4	1.880	109.9	815	0.0035
6/28/02	33	8:30a	6/28/02 8:30	32.75	91.1	2.130	105.3	1030	0.0039
6/28/02	33	3:40p	6/28/02 15:40	33.05	91.1	2.190	104.5	1040	0.0041
6/29/02	34	10:20a	6/29/02 10:20	33.83	91.1	2.350	102.9	1060	0.0044
6/29/02	34	6:05p	6/29/02 18:05	34.15	91.1	3.460	93.8	1090	0.0064
6/30/02	35	8:00a	6/30/02 8:00	34.73	94.1	9.060	74.9	1080	0.0168
6/30/02	35	4:30p	6/30/02 16:30	35.08	94.1	16.100	60.1	1080	0.0298
7/1/02	36	6:50a	7/1/02 6:50	35.68	94.1	32.700	41.7	1110	0.0606
7/1/02	36	5:35p	7/1/02 17:35	36.13	94.1	48.500	31.6	1140	0.0898
7/2/02	37	9:30a	7/2/02 9:30	36.79	93.9	71.000	19.1	1100	0.1315
7/2/02	37	5:35p	7/2/02 17:35	37.13	93.9	84.200	14.8	1210	0.1559
7/3/02	38	10:05a	7/3/02 10:05	37.82	93.9	102.000	10.1	1210	0.1889
7/3/02	38	5:30p	7/3/02 17:30	38.13	93.9	105.000	9.3	1220	0.1944
7/4/02	39	11:35a	7/4/02 11:35	38.88	91.9	125.000	11.6	1210	0.2315
7/4/02	39	6:00p	7/4/02 18:00	39.15	91.9	127.000	11.1	1230	0.2352
7/5/02	40	9:25a	7/5/02 9:25	39.79	91.9	119.000	12.8	1230	0.2204
7/5/02	40	7:05p	7/5/02 19:05	40.19	91.9	111.000	14.5	1220	0.2056
7/6/02	41	11:10a	7/6/02 11:10	40.86	97.1	68.900	22.4	1040	0.1276
7/6/02	41	6:45P	7/6/02 18:45	41.18	97.1	61.800	25.1	1070	0.1144
7/7/02	42	11:20A	7/7/02 11:20	41.87	97.1	42.500	34.6	1040	0.0787
7/7/02	42	9:10p	7/7/02 21:10	42.28	97.1	31.200	42.4	1030	0.0578
7/9/02	44	9:30a	7/8/02 9:30	42.79	96.1	8.340	74.2	910	0.0154
7/9/02	44	3:55p	7/9/02 15:55	44.06	96.1	6.730	79.5	892	0.0125
7/10/02	45	10:20a	7/10/02 10:20	44.83	97.1	3.520	97.3	898	0.0065
7/10/02	45	4:35p	7/10/02 16:35	45.09	97.1	3.040	101.0	880	0.0056
7/11/02	46	10:10a	7/11/02 10:10	45.82	97.1	2.120	110.0	866	0.0039
7/12/02	47	9:25a	7/12/02 9:25	46.79	97.1	1.470	120.5	879	0.0027
7/12/02	47	4:40p	7/12/02 16:40	47.09	97.1	1.370	122.2	873	0.0025
7/13/02	48	10:45a	7/13/02 10:45	47.84	97.1	1.300	123.5	877	0.0024
7/14/02	49	12:05p	7/14/02 12:05	48.90	97.3	1.120	126.2	871	0.0021
7/15/02	50	10:05a	7/15/02 10:05	49.82	97.1	1.010	127.9	869	0.0019
7/16/02	51	10:50a	7/16/02 10:50	50.85	98.2	0.987	131.5	861	0.0018
7/17/02	52	11:10a	7/17/02 11:10	51.86	96.1	0.976	128.9	848	0.0018
7/18/02	53	10:30a	7/18/02 10:30	52.83	94.8	0.872	127.7	835	0.0016
7/19/02	54	9:45a	7/19/02 9:45	53.80	94.8	0.856	128.2	829	0.0016
7/20/02	55	11:05a	7/20/02 11:05	54.86	93.9	0.774	129.3	835	0.0014
7/21/02	56	11:10a	7/21/02 11:10	55.86	93.9	0.774	129.3	818	0.0014
7/22/02	57	9:10a	7/22/02 9:10	56.78	94.6	0.812	130.3	822	0.0015
7/23/02	58	10:45a	7/23/02 10:45	57.84	96.5	0.809	130.3	828	0.0015
7/24/02	59	11:15a	7/24/02 11:15	58.86	97.7	0.841	131.6	825	0.0016
7/25/02	60	10:30a	7/25/02 10:30	59.83	97.5	0.999	126.6	822	0.0019
7/26/02	61	10:00a	7/26/02 10:00	60.81	96.5	0.809	130.0	824	0.0015

Table A-8. Test 1 Outlet Data. F) Column 6 (Continued)

Column # 6 Outlet				Location (cm)	192.8	EC (uS/cm)	1750	Br- (mg/L)	537
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.706	1375.5	818	0.0013
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	0.774	133	995	0.0014
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.766	130.5	981	0.0014
6/6/02	11	10:30a	6/6/02 10:30	10.83	93.1	1.330	118.6	964	0.0025
6/10/02	15	11:30a	6/10/02 11:30	14.88	93.6	1.590	113.4	1030	0.0030
6/13/02	18	2:50p	6/13/02 14:50	18.01	94.8	1.600	117.3	893	0.0030
6/17/02	22	9:20a	6/17/02 9:20	21.78	93.3	1.110	121.7	966	0.0021
6/20/02	25	5:25p	6/20/02 17:25	25.12	91.7	1.090	124.0	944	0.0020
6/21/02	26	10:10a	6/21/02 10:10	25.82	91.7	1.080	124.3	947	0.0020
6/22/02	27	10:00a	6/22/02 10:00	26.81	90.6	1.150	120.1	910	0.0021
6/22/02	27	4:45p	6/22/02 16:45	27.09	90.6	1.170	119.9	921	0.0022
6/23/02	28	11:50a	6/23/02 11:50	27.89	90.2	2.050	106.3	984	0.0038
6/23/02	28	6:20p	6/23/02 18:20	28.16	90.2	3.920	91.3	993	0.0073
6/24/02	29	8:45a	6/24/02 8:45	28.76	90.6	13.600	62.6	1040	0.0253
6/24/02	29	5:20p	6/24/02 17:20	29.12	90.6	22.200	50.2	1060	0.0413
6/25/02	30	8:10a	6/25/02 8:10	29.74	94.1	39.400	35.8	1060	0.0734
6/25/02	30	10:25p	6/25/02 22:25	30.33	94.1	65.300	23.1	1080	0.1216
6/26/02	31	8:45a	6/26/02 8:45	30.76	90.4	86.400	16.1	930	0.1609
6/26/02	31	5:00p	6/26/02 17:00	31.10	90.4	108.000	10.6	950	0.2011
6/27/02	32	9:05a	6/27/02 9:05	31.77	90.4	141.000	3.8	964	0.2626
6/27/02	32	5:05p	6/27/02 17:05	32.11	90.4	158.000	1.1	1010	0.2942
6/28/02	33	8:35a	6/28/02 8:35	32.75	91.1	169.000	-1.4	1330	0.3147
6/28/02	33	3:45p	6/28/02 15:45	33.05	91.1	173.000	-1.9	1350	0.3222
6/29/02	34	10:35a	6/29/02 10:35	33.84	91.1	158.000	0.4	1360	0.2942
6/29/02	34	6:15p	6/29/02 18:15	34.16	91.1	144.000	2.7	1370	0.2682
6/30/02	35	8:10a	6/30/02 8:10	34.74	94.1	115.000	9.5	1300	0.2142
6/30/02	35	4:40p	6/30/02 16:40	35.09	94.1	93.400	14.8	1300	0.1739
7/1/02	36	6:55a	7/1/02 6:55	35.68	94.1	63.100	24.8	1260	0.1175
7/1/02	36	5:40p	7/1/02 17:40	36.13	94.1	44.200	34.0	1230	0.0823
7/2/02	37	9:40a	7/2/02 9:40	36.80	93.9	24.700	45.6	1150	0.0460
7/2/02	37	5:45p	7/2/02 17:45	37.14	93.9	18.000	53.6	1180	0.0335
7/3/02	38	10:15a	7/3/02 10:15	37.82	93.9	10.100	68.1	1180	0.0188
7/3/02	38	5:40p	7/3/02 17:40	38.13	93.9	7.590	75.2	1180	0.0141
7/4/02	39	11:45a	7/4/02 11:45	38.89	91.9	5.200	91.0	1150	0.0097
7/4/02	39	6:10p	7/4/02 18:10	39.15	91.9	4.150	96.4	1160	0.0077
7/5/02	40	9:40a	7/5/02 9:40	39.80	91.9	3.010	103.9	1120	0.0056
7/5/02	40	7:15p	7/5/02 19:15	40.20	91.9	2.460	108.7	1160	0.0046
7/6/02	41	11:20a	7/6/02 11:20	40.87	97.1	2.120	110.0	1010	0.0039
7/6/02	41	6:55p	7/6/02 18:55	41.18	97.1	1.790	114.3	1010	0.0033
7/7/02	42	11:30a	7/7/02 11:30	41.88	97.1	1.550	117.8	1000	0.0029
7/7/02	42	9:15p	7/7/02 21:15	42.28	97.1	1.420	120.1	1000	0.0026
7/8/02	43	10:20a	7/8/02 10:20	42.83	96.1	1.440	117.7	865	0.0027
7/9/02	44	4:00p	7/9/02 16:00	44.06	96.1	1.190	122.4	896	0.0022
7/10/02	45	10:20a	7/10/02 10:20	44.83	97.1	1.270	122.9	878	0.0024
7/11/02	46	10:10a	7/11/02 10:10	45.82	97.1	1.220	123.9	870	0.0023
7/12/02	47	4:45p	7/12/02 16:45	47.09	97.1	1.120	127.3	862	0.0021
7/13/02	48	10:55a	7/13/02 10:55	47.85	97.1	1.050	128.8	848	0.0020
7/14/02	49	12:15p	7/14/02 12:15	48.91	97.3	0.980	129.6	840	0.0018
7/15/02	50	10:15a	7/15/02 10:15	49.82	97.1	0.893	131.0	851	0.0017
7/16/02	51	11:00a	7/16/02 11:00	50.85	98.2	0.989	131.4	842	0.0018
7/17/02	52	11:15a	7/17/02 11:15	51.86	96.1	0.982	131.4	821	0.0018
7/18/02	53	10:40a	7/18/02 10:40	52.84	94.8	0.799	129.9	818	0.0015
7/19/02	54	9:55a	7/19/02 9:55	53.81	94.8	0.779	130.5	829	0.0015
7/20/02	55	11:15a	7/20/02 11:15	54.86	93.9	0.743	130.3	832	0.0014
7/21/02	56	11:15a	7/21/02 11:15	55.86	93.9	0.735	130.5	837	0.0014
7/22/02	57	9:20a	7/22/02 9:20	56.78	94.6	0.817	130.2	829	0.0015
7/23/02	58	10:55a	7/23/02 10:55	57.85	96.5	0.809	130.3	846	0.0015
7/24/02	59	11:25a	7/24/02 11:25	58.87	97.7	0.841	131.6	842	0.0016
7/25/02	60	10:35a	7/25/02 10:35	59.84	97.5	0.845	130.8	845	0.0016
7/26/02	61	10:10a	7/26/02 10:10	60.82	96.5	0.770	131.2	836	0.0014

Table A-8. Test 1 Outlet Data. G) Column 7 (Continued)

Column # 7 Outlet				Location (cm)	191.2	EC (uS/cm)	1750	Br- (mg/L)	535
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.726	1374.8		0.0014
5/28/02	2	4:00p	5/28/02 16:00	2.06	94.8	0.855	130.5	1010	0.0016
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.902	126.5	1000	0.0017
6/6/02	11	10:25a	6/6/02 10:25	10.83	93.1	5.020	87.0	1130	0.0094
6/10/02	15	11:25a	6/10/02 11:25	14.87	93.6	2.220	105.0	1110	0.0041
6/13/02	18	2:40p	6/13/02 14:40	18.01	90.2	2.280	105.6	904	0.0043
6/17/02	22	9:15a	6/17/02 9:15	21.78	93.3	1.220	119.7	955	0.0023
6/20/02	25	9:30a	6/20/02 9:30	24.79	91.7	1.150	122.8	912	0.0021
6/21/02	26	9:55a	6/21/02 9:55	25.81	91.7	1.160	122.6	911	0.0022
6/22/02	27	9:50a	6/22/02 9:50	26.81	90.6	1.230	118.7	861	0.0023
6/22/02	27	4:40p	6/22/02 16:40	27.09	90.6	1.310	117.2	860	0.0024
6/23/02	28	11:40a	6/23/02 11:40	27.88	90.2	1.520	113.0	942	0.0028
6/23/02	28	6:10p	6/23/02 18:10	28.15	90.2	1.510	113.4	953	0.0028
6/24/02	29	8:35a	6/24/02 8:35	28.75	90.6	1.710	111.7	969	0.0032
6/24/02	29	5:10p	6/24/02 17:10	29.11	90.6	1.710	111.8	973	0.0032
6/25/02	30	8:05a	6/25/02 8:05	29.73	94.1	1.880	110.7	987	0.0035
6/25/02	30	10:20p	6/25/02 22:20	30.33	94.1	2.010	109.1	984	0.0038
6/26/02	31	8:35a	6/26/02 8:35	30.75	90.4	2.540	102.1	801	0.0047
6/26/02	31	4:50p	6/26/02 16:50	31.10	90.4	3.990	91.6	824	0.0075
6/27/02	32	8:55a	6/27/02 8:55	31.77	90.4	12.000	65.3	753	0.0224
6/27/02	32	5:00p	6/27/02 17:00	32.10	90.4	21.500	50.9	831	0.0402
6/28/02	33	8:30a	6/28/02 8:30	32.75	91.1	41.200	33.5	1110	0.0770
6/28/02	33	3:40p	6/28/02 15:40	33.05	91.1	51.400	28.0	1130	0.0961
6/29/02	34	10:20a	6/29/02 10:20	33.83	91.1	67.000	21.4	1150	0.1252
6/29/02	34	6:10p	6/29/02 18:10	34.15	91.1	71.300	19.9	1180	0.1333
6/30/02	35	8:00a	6/30/02 8:00	34.73	94.1	69.000	22.5	1180	0.1290
6/30/02	35	4:30p	6/30/02 16:30	35.08	94.1	64.900	24.1	1190	0.1213
7/1/02	36	6:50a	7/1/02 6:50	35.68	94.1	52.400	29.6	1180	0.0979
7/1/02	36	5:35p	7/1/02 17:35	36.13	94.1	40.300	36.4	1170	0.0753
7/2/02	37	9:30a	7/2/02 9:30	36.79	93.9	23.500	40.9	1120	0.0439
7/2/02	37	5:35p	7/2/02 17:35	37.13	93.9	18.800	52.4	1130	0.0351
7/3/02	38	10:05a	7/3/02 10:05	37.82	93.9	11.700	64.4	1140	0.0219
7/3/02	38	5:35p	7/3/02 17:35	38.13	93.9	9.620	69.3	1150	0.0180
7/4/02	39	6:00p	7/4/02 18:00	39.15	91.9	5.930	87.9	1140	0.0111
7/5/02	40	9:30a	7/5/02 9:30	39.79	91.9	4.540	94.2	1130	0.0085
7/5/02	40	7:05p	7/5/02 19:05	40.19	91.9	3.880	97.9	1140	0.0073
7/6/02	41	11:15a	7/6/02 11:15	40.86	97.1	2.500	105.9	1000	0.0047
7/6/02	41	6:45p	7/6/02 18:45	41.18	97.1	2.460	106.3	1000	0.0046
7/7/02	42	11:20a	7/7/02 11:20	41.87	97.1	2.110	110.2	996	0.0039
7/7/02	42	9:10p	7/7/02 21:10	42.28	97.1	1.840	113.6	996	0.0034
7/8/02	43	10:10a	7/8/02 10:10	42.82	96.1	1.470	117.1	898	0.0027
7/9/02	44	3:55p	7/9/02 15:55	44.06	96.1	1.170	122.9	881	0.0022
7/10/02	45	10:20a	7/10/02 10:20	44.83	97.1	1.270	122.9	878	0.0024
7/11/02	46	10:10a	7/11/02 10:10	45.82	97.1	1.220	123.9	870	0.0023
7/12/02	47	4:40p	7/12/02 16:40	47.09	97.1	1.130	127.0	853	0.0021
7/13/02	48	10:45a	7/13/02 10:45	47.84	97.1	1.120	127.3	850	0.0021
7/14/02	49	12:10p	7/14/02 12:10	48.90	97.3	1.020	128.6	839	0.0019
7/15/02	50	10:05a	7/15/02 10:05	49.82	97.1	0.973	128.8	842	0.0018
7/16/02	51	10:50a	7/16/02 10:50	50.85	98.2	0.936	132.8	836	0.0017
7/17/02	52	11:10a	7/17/02 11:10	51.86	96.1	0.880	131.5	824	0.0016
7/18/02	53	10:35a	7/18/02 10:35	52.84	94.8	0.843	128.6	808	0.0016
7/19/02	54	9:50a	7/19/02 9:50	53.81	94.8	0.835	128.8	810	0.0016
7/20/02	55	11:10a	7/20/02 11:10	54.86	93.9	0.796	128.6	818	0.0015
7/21/02	56	11:10a	7/21/02 11:10	55.86	93.9	0.803	128.4	822	0.0015
7/22/02	57	9:15a	7/22/02 9:15	56.78	94.6	0.840	129.5	822	0.0016
7/23/02	58	10:45a	7/23/02 10:45	57.84	96.5	0.815	130.1	820	0.0015
7/24/02	59	11:15a	7/24/02 11:15	58.86	97.7	0.860	131.0	832	0.0016
7/25/02	60	10:30a	7/25/02 10:30	59.83	97.5	0.828	131.3	833	0.0015
7/26/02	61	10:05a	7/26/02 10:05	60.82	96.5	0.802	130.2	821	0.0015

Table A-8. Test 1 Outlet Data. H) Column 8 (Continued)

Column # 8 Outlet				Location (cm)	190.4	EC (uS/cm)	1750	Br- (mg/L)	546
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.743	1374.2		0.0014
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.921	126.0	876	0.0017
6/6/02	11	10:25a	6/6/02 10:25	10.83	93.1	2.630	102.5	938	0.0048
6/10/02	15	11:25a	6/10/02 11:25	14.87	93.6	2.720	100.5	1050	0.0050
6/13/02	18	2:45p	6/13/02 14:45	18.01	90.2	2.150	106.6	924	0.0039
6/17/02	22	9:15a	6/17/02 9:15	21.78	93.3	1.450	115.4	1020	0.0027
6/20/02	25	9:30a	6/20/02 9:30	24.79	91.7	1.250	120.9	956	0.0023
6/21/02	26	10:05a	6/21/02 10:05	25.82	91.7	1.430	117.8	994	0.0026
6/22/02	27	9:50a	6/22/02 9:50	26.81	90.6	4.240	89.9	930	0.0078
6/22/02	27	4:40p	6/22/02 16:40	27.09	90.6	7.610	76.2	952	0.0139
6/23/02	28	11:45a	6/23/02 11:45	27.89	90.2	16.100	57.6	1010	0.0295
6/23/02	28	6:15p	6/23/02 18:15	28.16	90.2	29.700	42.5	1010	0.0544
6/24/02	29	8:35a	6/24/02 8:35	28.75	90.6	78.200	18.5	1060	0.1432
6/24/02	29	5:15p	6/24/02 17:15	29.11	90.6	125.000	6.9	1140	0.2289
6/25/02	30	8:05a	6/25/02 8:05	29.73	94.1	181.000	-2.3	1180	0.3315
6/25/02	30	10:20p	6/25/02 22:20	30.33	94.1	228.000	-8.1	1230	0.4176
6/26/02	31	8:40a	6/26/02 8:40	30.76	90.4	238.000	-9.2	1040	0.4359
6/26/02	31	4:55p	6/26/02 16:55	31.10	90.4	228.000	-8.2	1050	0.4176
6/27/02	32	8:55a	6/27/02 8:55	31.77	90.4	192.000	-3.9	1010	0.3516
6/27/02	32	5:00p	6/27/02 17:00	32.10	90.4	166.000	0.2	1010	0.3040
6/28/02	33	8:30a	6/28/02 8:30	32.75	91.1	116.000	8.0	1250	0.2125
6/28/02	33	3:40p	6/28/02 15:40	33.05	91.1	90.600	14.0	1260	0.1659
6/29/02	34	10:25a	6/29/02 10:25	33.83	91.1	42.600	32.7	1230	0.0780
6/29/02	34	6:10p	6/29/02 18:10	34.15	91.1	28.500	42.7	1240	0.0522
6/30/02	35	8:05a	6/30/02 8:05	34.73	94.1	15.600	60.8	1200	0.0286
6/30/02	35	4:35p	6/30/02 16:35	35.09	94.1	10.100	72.2	1170	0.0185
7/1/02	36	6:50a	7/1/02 6:50	35.68	94.1	5.790	85.9	1160	0.0106
7/1/02	36	5:40p	7/1/02 17:40	36.13	94.1	7.030	94.7	1150	0.0129
7/2/02	37	9:35a	7/2/02 9:35	36.80	93.9	2.920	98.3	1080	0.0053
7/2/02	37	5:40p	7/2/02 17:40	37.13	93.9	2.320	103.8	1090	0.0042
7/3/02	38	10:05a	7/3/02 10:05	37.82	93.9	1.820	109.6	1130	0.0033
7/3/02	38	5:35p	7/3/02 17:35	38.13	93.9	1.690	111.5	1150	0.0031
7/4/02	39	11:40a	7/4/02 11:40	38.88	91.9	1.880	115.1	1110	0.0034
7/4/02	39	6:00p	7/4/02 18:00	39.15	91.9	1.650	118.2	1130	0.0030
7/5/02	40	9:30a	7/5/02 9:30	39.79	91.9	1.520	120.0	1120	0.0028
7/5/02	40	7:10p	7/5/02 19:10	40.19	91.9	1.470	120.9	1120	0.0027
7/6/02	41	11:15a	7/6/02 11:15	40.86	97.1	1.530	118.2	992	0.0028
7/6/02	41	6:45p	7/6/02 18:45	41.18	97.1	1.380	120.8	985	0.0025
7/7/02	42	11:20a	7/7/02 11:20	41.87	97.1	1.300	122.3	987	0.0024
7/7/02	42	9:10p	7/7/02 21:10	42.28	97.1	1.260	123.0	978	0.0023
7/8/02	43	10:10a	7/8/02 10:10	42.82	96.1	1.220	121.8	876	0.0022
7/9/02	44	3:55p	7/9/02 15:55	44.06	96.1	1.140	123.5	864	0.0021
7/10/02	45	10:25a	7/10/02 10:25	44.83	97.1	1.150	125.2	860	0.0021
7/11/02	46	10:15a	7/11/02 10:15	45.82	97.1	1.100	126.4	852	0.0020
7/12/02	47	4:45p	7/12/02 16:45	47.09	97.1	1.080	128.2	845	0.0020
7/13/02	48	10:50a	7/13/02 10:50	47.85	97.1	1.050	128.8	840	0.0019
7/14/02	49	12:10p	7/14/02 12:10	48.90	97.3	0.996	129.2	825	0.0018
7/15/02	50	10:10a	7/15/02 10:10	49.82	97.1	0.971	130.3	831	0.0018
7/16/02	51	10:55a	7/16/02 10:55	50.85	98.2	0.876	134.5	831	0.0016
7/17/02	52	11:10a	7/17/02 11:10	51.86	96.1	0.843	132.6	823	0.0015
7/18/02	53	10:35a	7/18/02 10:35	52.84	94.8	0.815	129.4	820	0.0015
7/19/02	54	9:50a	7/19/02 9:50	53.81	94.8	0.827	129.1	839	0.0015
7/20/02	55	11:10a	7/20/02 11:10	54.86	93.9	0.778	129.2	834	0.0014
7/21/02	56	11:15a	7/21/02 11:15	55.86	93.9	0.758	129.8	842	0.0014
7/22/02	57	9:15a	7/22/02 9:15	56.78	94.6	0.840	129.5	828	0.0015
7/23/02	58	10:50a	7/23/02 10:50	57.85	96.5	0.796	130.7	843	0.0015
7/24/02	59	11:20a	7/24/02 11:20	58.87	97.7	0.841	131.6	834	0.0015
7/25/02	60	10:35a	7/25/02 10:35	59.84	97.5	0.789	132.5	834	0.0014
7/26/02	61	10:05a	7/26/02 10:05	60.82	96.5	0.764	131.4	815	0.0014

Table A-8. Test 1 Outlet Data. I) Column 9 (Continued)

Column # 9 Outlet				Location (cm)	187.9	EC (uS/cm)	1760	Br- (mg/L)	544
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	5/26/02 14:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
5/22/02	0				98.8	0.726	1374.8		0.0013
5/27/02	1	12:00p	5/27/02 12:00	0.90	95.3	0.886	1364.3	1030	0.0016
5/30/02	4	3:00p	5/30/02 15:00	4.02	93.9	0.888	126.9	1020	0.0016
6/6/02	11	10:35a	6/6/02 10:35	10.84	93.1	1.760	111.8	990	0.0032
6/10/02	15	11:40a	6/10/02 11:40	14.88	93.6	1.970	108.1	1120	0.0036
6/13/02	18	2:50p	6/13/02 14:50	18.01	90.2	1.640	112.8	965	0.0030
6/17/02	22	9:35a	6/17/02 9:35	21.80	93.3	1.440	115.5	1030	0.0026
6/20/02	25	5:30p	6/20/02 17:30	25.13	91.7	16.100	59.2	968	0.0296
6/21/02	26	10:10a	6/21/02 10:10	25.82	91.7	30.800	42.9	979	0.0566
6/22/02	27	10:05a	6/22/02 10:05	26.82	90.6	63.600	23.0	999	0.1169
6/22/02	27	4:50p	6/22/02 16:50	27.10	90.6	73.600	19.3	1.04	0.1353
6/23/02	28	11:55a	6/23/02 11:55	27.89	90.2	109.000	10.5	1080	0.2004
6/23/02	28	6:25p	6/23/02 18:25	28.16	90.2	121.000	7.9	1110	0.2224
6/24/02	29	8:45a	6/24/02 8:45	28.76	90.6	133.000	5.4	1180	0.2445
6/24/02	29	5:25p	6/24/02 17:25	29.12	90.6	148.000	2.8	1200	0.2721
6/25/02	30	8:15a	6/25/02 8:15	29.74	94.1	160.000	0.8	1220	0.2941
6/25/02	30	10:30p	6/25/02 22:30	30.33	94.1	165.000	0.0	1220	0.3033
6/26/02	31	8:50a	6/26/02 8:50	30.76	90.4	171.000	-1.0	1010	0.3143
6/26/02	31	5:00p	6/26/02 17:00	31.10	90.4	171.000	-1.0	1020	0.3143
6/27/02	32	9:05a	6/27/02 9:05	31.77	90.4	165.000	0.0	925	0.3033
6/27/02	32	5:10p	6/27/02 17:10	32.11	90.4	153.000	1.8	1030	0.2813
6/28/02	33	8:40a	6/28/02 8:40	32.76	91.1	139.000	3.6	1310	0.2555
6/28/02	33	3:50p	6/28/02 15:50	33.06	91.1	127.000	5.7	1330	0.2335
6/29/02	34	10:35a	6/29/02 10:35	33.84	91.1	96.200	12.5	1330	0.1768
6/29/02	34	6:20p	6/29/02 18:20	34.16	91.1	82.400	16.3	1320	0.1515
6/30/02	35	8:15a	6/30/02 8:15	34.74	94.1	63.900	24.5	1220	0.1175
6/30/02	35	4:45p	6/30/02 16:45	35.09	94.1	52.600	29.5	1230	0.0967
7/1/02	36	7:00a	7/1/02 7:00	35.69	94.1	37.600	38.2	1220	0.0691
7/1/02	36	5:45p	7/1/02 17:45	36.14	94.1	28.200	45.6	1120	0.0518
7/2/02	37	9:45a	7/2/02 9:45	36.80	93.9	16.500	55.8	1190	0.0303
7/2/02	37	5:45p	7/2/02 17:45	37.14	93.9	13.400	61.0	1190	0.0246
7/3/02	38	10:15a	7/3/02 10:15	37.82	93.9	8.300	73.0	1180	0.0153
7/3/02	38	5:45p	7/3/02 17:45	38.14	93.9	6.840	77.7	1170	0.0126
7/4/02	39	11:50a	7/4/02 11:50	38.89	91.9	4.390	95.0	1160	0.0081
7/4/02	39	6:10p	7/4/02 18:10	39.15	91.9	3.960	97.4	1100	0.0073
7/5/02	40	9:45a	7/5/02 9:45	39.80	91.9	3.010	103.9	1150	0.0055
7/5/02	40	7:20p	7/5/02 19:20	40.20	91.9	2.530	108.1	1150	0.0047
7/6/02	41	11:25a	7/6/02 11:25	40.87	97.1	1.760	114.7	1010	0.0032
7/6/02	41	6:55p	7/6/02 18:55	41.18	97.1	1.640	116.4	976	0.0030
7/7/02	42	11:30a	7/7/02 11:30	41.88	97.1	1.500	118.6	1010	0.0028
7/7/02	42	9:20p	7/7/02 21:20	42.28	97.1	1.450	119.6	1000	0.0027
7/8/02	43	10:20a	7/8/02 10:20	42.83	96.1	1.190	122.5	881	0.0022
7/9/02	44	4:00p	7/9/02 16:00	44.06	96.1	1.080	124.7	886	0.0020
7/10/02	45	10:30a	7/10/02 10:30	44.83	97.1	1.130	125.8	867	0.0021
7/11/02	46	10:20a	7/11/02 10:20	45.83	97.1	1.130	125.8	872	0.0021
7/12/02	47	4:50p	7/12/02 16:50	47.10	97.1	1.090	122.8	851	0.0020
7/13/02	48	10:55a	7/13/02 10:55	47.85	97.1	1.050	128.8	850	0.0019
7/14/02	49	12:15p	7/14/02 12:15	48.91	97.3	1.010	128.9	845	0.0019
7/15/02	50	10:15a	7/15/02 10:15	49.82	97.1	0.928	130.0	851	0.0017
7/16/02	51	11:00a	7/16/02 11:00	50.85	98.2	0.941	132.7	847	0.0017
7/17/02	52	11:15a	7/17/02 11:15	51.86	96.1	0.972	131.7	833	0.0018
7/18/02	53	10:40a	7/18/02 10:40	52.84	94.8	0.809	129.6	821	0.0015
7/19/02	54	9:55a	7/19/02 9:55	53.81	94.8	0.802	129.8	834	0.0015
7/20/02	55	11:15a	7/20/02 11:15	54.86	93.9	0.755	129.9	835	0.0014
7/21/02	56	11:20a	7/21/02 11:20	55.87	93.9	0.750	130.1	835	0.0014
7/22/02	57	9:20a	7/22/02 9:20	56.78	94.6	0.812	130.3	839	0.0015
7/23/02	58	10:55a	7/23/02 10:55	57.85	96.5	0.951	126.2	844	0.0017
7/24/02	59	11:25a	7/24/02 11:25	58.87	97.7	0.855	131.2	840	0.0016
7/25/02	60	10:40a	7/25/02 10:40	59.84	97.5	0.792	132.4	836	0.0015
7/26/02	61	10:10a	7/26/02 10:10	60.82	96.5	0.784	130.8	827	0.0014

Peak day avg 30.93

Table A-9. Test 1 Port A CXTFIT Data. A) Column 1 (2 pages)

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 *******************************************************************
 *                                                                 *
 *   CXTFIT VERSION 2.1 (4/17/99)                                  *
 *   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
 *   NON-LINEAR LEAST-SQUARES ANALYSIS                             *
 *                                                                 *
 *   Comment                                                       *
 *   Comment                                                       *
 *                                                                 *
 *   DATA INPUT FILE: port2in.in                                   *
 *                                                                 *
 *******************************************************************


 MODEL DESCRIPTION
 =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME      INITIAL VALUE  FITTING
  V........   .4800E+01     Y
  D........   .1830E+02     Y
  R........   .1000E+01     N
  mu.......   .0000E+00     N


 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
   SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
   SOLUTE FREE INITIAL CONDITION
   NO PRODUCTION TERM


 PARAMETER ESTIMATION MODE
 =========================
   MAXIMUM NUMBER OF ITERATIONS =  50


 ITER    SSQ       V....    D....
  0  .7896E+00 .480E+01 .183E+02
  1  .5177E+00 .739E+01 .623E+02
  2  .3312E+00 .731E+01 .312E+02
  3  .1519E+00 .725E+01 .156E+02
  4  .3728E-01 .723E+01 .817E+01
  5  .1751E-01 .721E+01 .540E+01
  6  .1731E-01 .722E+01 .558E+01
  7  .1731E-01 .722E+01 .560E+01
  8  .1731E-01 .722E+01 .560E+01

 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
          V....  D....
   V....  1.000
   D....  -.054  1.000

   RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .97460682
   (COEFFICIENT OF DETERMINATION)

  MEAN SQUARE FOR ERROR (MSE) =  .2473E-02


 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
 ================================================

                                    95% CONFIDENCE LIMITS
 NAME    VALUE    S.E.COEFF. T-VALUE    LOWER      UPPER
 V....  .7218E+01  .8927E-01 .8086E+02  .7007E+01  .7429E+01
 D....  .5598E+01  .7211E+00 .7763E+01  .3893E+01  .7304E+01
```

-----------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	61	7.9861	0.2586	0.3599	-0.1012
2	61	9.8646	0.7146	0.7412	-0.0267
3	61	10.2986	0.7184	0.7171	0.0013
4	61	11	0.5441	0.5879	-0.0438
5	61	11.7986	0.3352	0.3827	-0.0475
6	61	12.9063	0.1092	0.1544	-0.0452
7	61	13.9236	0.0404	0.0516	-0.0112
8	61	14.8472	0.0185	0.016	0.0025
9	61	23.8056	0.0011	0	0.0011

(Table continued on next page)

Table A-9. Test 1 Port A CXTFIT Data. B) Column 2 (2 pages) (Continued)

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*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: port2in in                                  *
*                                                               *
*****************************************************************

MODEL DESCRIPTION
=================
 DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
 RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
 REAL TIME (t), POSITION(x)
  (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE   FITTING
V........  .4800E+01     Y
D........  .1830E+02     Y
R........  .1000E+01     N
mu.......  .0000E+00     N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ        V....     D....
0   .4388E+00  .480E+01  .183E+02
1   .2029E+00  .658E+01  .258E+02
2   .7942E-01  .618E+01  .129E+02
3   .5601E-01  .616E+01  .752E+01
4   .5414E-01  .617E+01  .835E+01
5   .5413E-01  .617E+01  .842E+01
6   .5413E-01  .617E+01  .842E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....  D....
 V....  1.000
 D....   .170  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .92571626
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .3609E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                                  95% CONFIDENCE LIMITS
NAME    VALUE     S.E.COEFF.  T-VALUE     LOWER      UPPER
V....  .6168E+01  .1069E+00  .5767E+02  .5940E+01  .6396E+01
D....  .8423E+01  .1314E+01  .6408E+01  .5621E+01  .1122E+02
```

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	61	1.2292	0.0018	0	0.0018
2	61	2.0625	0.0017	0	0.0017
3	61	4.0208	0.0018	0	0.0018
4	61	5.9375	0.0059	0.0068	-0.0009
5	61	8	0.128	0.1542	-0.0262
6	61	8.9132	0.2495	0.3025	-0.053
7	61	9.8854	0.4248	0.4575	-0.0327
8	61	10.2986	0.6343	0.5036	0.1307
9	61	11.0208	0.3752	0.5393	-0.1641
10	61	11.809	0.5543	0.5119	0.0424
11	61	12.9063	0.3695	0.3962	-0.0267
12	61	13.9271	0.259	0.2671	-0.0081
13	61	14.8507	0.1423	0.1686	-0.0263
14	61	16.0972	0.0387	0.08	-0.0413
15	61	17.0625	0.0178	0.0415	-0.0237
16	61	19.0903	0.0044	0.0088	-0.0044
17	61	23.7917	0.0019	0.0001	0.0018

Table A-9. Test 1 Port A CXTFIT Data. C) Column 3 (2 pages) (Continued)

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*                                                                   *
*   CXTFIT VERSION 2.1 (4/17/99)                                    *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                    *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                               *
*                                                                   *
*   Comment                                                         *
*   Comment                                                         *
*                                                                   *
*   DATA INPUT FILE: port2in in                                     *
*                                                                   *
*********************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME     INITIAL VALUE  FITTING
V.......  .4800E+01      Y
D.......  .1830E+02      Y
R.......  .1000E+01      N
mu......  .0000E+00      N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
  SINGLE PULSE OF CONC. =  1.0000 & DURATION =  3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
  MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ        V.....    D.....
0   .6976E+00  .480E+01  .183E+02
1   .4345E+00  .682E+01  .332E+02
2   .2506E+00  .628E+01  .166E+02
3   .9989E-01  .632E+01  .840E+01
4   .4953E-01  .637E+01  .445E+01
5   .4936E-01  .637E+01  .459E+01
6   .4935E-01  .637E+01  .461E+01
7   .4935E-01  .637E+01  .462E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V...   D...
  V...  1.000
  D...   .156  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .94756349
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .3525E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                                  95% CONFIDENCE LIMITS
NAME    VALUE    S.E.COEFF. T-VALUE    LOWER      UPPER
V...  .6369E+01  .7476E-01 .8519E+02  .6209E+01  .6530E+01
D...  .4616E+01  .6877E+00 .6712E+01  .3141E+01  .6091E+01
```

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
$ NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	61	1.23	0.0016	0	0.0016
2	61	4.02	0.0017	0	0.0017
3	61	5.9	0.0023	0.0007	0.0016
4	61	8	0.0568	0.1196	-0.0628
5	61	8.92	0.2205	0.3202	-0.0997
6	61	9.84	0.4848	0.5561	-0.0713
7	61	10.29	0.6255	0.643	-0.0175
8	61	10.97	0.6616	0.6973	-0.0357
9	61	11.79	0.5722	0.6253	-0.0531
10	61	12.91	0.2681	0.3869	-0.1188
11	61	13.92	0.0895	0.189	-0.0995
12	61	14.84	0.0371	0.081	-0.0439
13	61	16.05	0.0186	0.0211	-0.0025
14	61	17.05	0.0115	0.0059	0.0056
15	61	19.07	0.0027	0.0003	0.0024
16	61	23.78	0.0019	0	0.0019

Table A-9. Test 1 Port A CXTFIT Data. D) Column 4 (2 pages) (Continued)

```
$

 *******************************************************************
 *                                                                 *
 *   CXTFIT VERSION 2.1 (4/17/99)                                  *
 *   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
 *   NON-LINEAR LEAST-SQUARES ANALYSIS                             *
 *                                                                 *
 *   Comment                                                       *
 *   Comment                                                       *
 *                                                                 *
 *   DATA INPUT FILE: port3in.in                                   *
 *                                                                 *
 *******************************************************************

 MODEL DESCRIPTION
 =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME       INITIAL VALUE  FITTING
 V........   .4700E+01      Y
 D........   .1830E+02      Y
 R........   .1000E+01      N
 mu.......   .0000E+00      N

 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
  SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

 PARAMETER ESTIMATION MODE
 =========================
  MAXIMUM NUMBER OF ITERATIONS =  50

 ITER   SSQ      V....   D....
  0  .1089E+01  .470E+01  .183E+02
  1  .8955E+00  .718E+01  .536E+02
  2  .6514E+00  .647E+01  .268E+02
  3  .3972E+00  .650E+01  .134E+02
  4  .1551E+00  .671E+01  .670E+01
  5  .2928E-01  .675E+01  .349E+01
  6  .9186E-02  .676E+01  .217E+01
  7  .8675E-02  .676E+01  .231E+01
  8  .8672E-02  .676E+01  .232E+01
  9  .8672E-02  .676E+01  .232E+01

 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
         V....  D....
  V....  1.000
  D....   .006  1.000

  RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99089464
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   9636E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================
```

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6763E+01	.2712E-01	.2494E+03	.6702E+01	.6824E+01
D.....	.2325E+01	.2124E+00	.1094E+02	.1844E+01	.2805E+01

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	86	9.9	0.0061	0.0025	0.0036
2	86	10.31	0.0079	0.0092	-0.0013
3	86	10.98	0.023	0.0498	-0.0268
4	86	11.82	0.1638	0.2062	-0.0424
5	86	12.94	0.621	0.5745	0.0465
6	86	13.95	0.7505	0.8036	-0.0531
7	86	14.86	0.7524	0.7425	0.0099
8	86	16.066	0.3524	0.3764	-0.024
9	86	17.066	0.14	0.1286	0.0114
10	86	19.0903	0.023	0.0041	0.0189
11	86	23.8125	0.0021	0	0.0021

Table A-9. Test 1 Port A CXTFIT Data. E) Column 5 (2 pages) (Continued)

```
$

*******************************************************************
*                                                                 *
*   CXTFIT VERSION 2.1 (4/17/99)                                  *
*   ANALYTICALSOLUTIONS FOR ONE-DIMENSIONAL CDE                   *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                             *
*                                                                 *
*   Comment                                                       *
*   Comment                                                       *
*                                                                 *
*   DATA INPUT FILE: port3in.in                                   *
*                                                                 *
*******************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V.......    .4800E+01     Y
D.......    .1830E+02     Y
R.......    .1000E+01     N
mu......    .0000E+00     N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
  SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
  MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ       V...     D...
0   .1036E+01  .480E+01  .183E+02
1   .8921E+00  .732E+01  .523E+02
2   .6766E+00  .601E+01  .261E+02
3   .3731E+00  .672E+01  .131E+02
4   .1507E+00  .675E+01  .653E+01
5   .2866E-01  .679E+01  .344E+01
6   .6652E-02  .681E+01  .210E+01
7   .6192E-02  .681E+01  .223E+01
8   .6189E-02  .681E+01  .224E+01
9   .6189E-02  .681E+01  .224E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V...   D...
  V...  1.000
  D...  -.013  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99415902
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .5627E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================
```

			95% CONFIDENCE LIMITS	
NAME VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V.... .6810E+01	.2042E-01	.3334E+03	.6765E+01	.6855E+01
D.... .2242E+01	.1576E+00	.1423E+02	.1895E+01	.2588E+01

------------------ORDERED BY COMPUTER INPUT------------------

$ NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	86	4.0208	0.0017	0	0.0017
2	86	5.8958	0.0018	0	0.0018
3	86	7.9792	0.0026	0	0.0026
4	86	8.9306	0.0024	0	0.0023
5	86	10.3194	0.0093	0.0103	-0.0009
6	86	11.0208	0.0357	0.0593	-0.0236
7	86	11.8125	0.1944	0.2221	-0.0277
8	86	12.9167	0.5759	0.5992	-0.0233
9	86	13.941	0.8352	0.8213	0.0139
10	86	14.8507	0.7019	0.7351	-0.0333
11	86	16.0486	0.3074	0.3509	-0.0435
12	86	17.0486	0.138	0.1108	0.0272
13	86	19.0799	0.022	0.0028	0.0193

Table A-9. Test 1 Port A CXTFIT Data. F) Column 6 (2 pages) (Continued)

```
*******************************************************************
*                                                                 *
*  CXTFIT VERSION 2.1 (4/17/99)                                   *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                   *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                              *
*                                                                 *
*  Comment                                                        *
*  Comment                                                        *
*                                                                 *
*  DATA INPUT FILE: port2in.in                                    *
*                                                                 *
*******************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V........   .4800E+01      Y
D........   .1830E+02      Y
R........   .1000E+01      N
mu.......   .0000E+00      N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =  1.0000 & DURATION =  3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ       V....    D....
0   .6501E+00  .480E+01  .183E+02
1   .3834E+00  .716E+01  .330E+02
2   .1735E+00  .626E+01  .165E+02
3   .2695E-01  .650E+01  .875E+01
4   .7365E-02  .658E+01  .606E+01
5   .6767E-02  .658E+01  .641E+01
6   .6764E-02  .657E+01  .642E+01
7   .6764E-02  .657E+01  .642E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....  D....
 V....  1.000
 D....   .130  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99120878
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .6149E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                              95% CONFIDENCE LIMITS
NAME    VALUE    S.E.COEFF.  T-VALUE    LOWER      UPPER
V....  .6574E+01  .3894E-01  .1688E+03  .6489E+01  .6660E+01
D....  .6416E+01  .3806E+00  .1686E+02  .5579E+01  .7254E+01
```

-----------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	61	1.2292	0.002	0	0.002
2	61	2.0625	0.0018	0	0.0018
3	61	4.0208	0.0017	0	0.0017
4	61	6.9271	0.0315	0.0491	-0.0176
5	61	8.0104	0.1534	0.203	-0.0496
6	61	8.9063	0.3966	0.4031	-0.0065
7	61	9.8611	0.5996	0.5899	0.0097
8	61	10.3125	0.6592	0.6346	0.0246
9	61	10.9792	0.6108	0.6313	-0.0205
10	61	11.809	0.4767	0.5288	-0.0521
11	61	12.9271	0.324	0.3218	0.0022
12	61	13.9549	0.1601	0.1645	-0.0044
13	61	14.8681	0.0879	0.0788	0.0091

Table A-9. Test 1 Port A CXTFIT Data. G) Column 7 (2 pages) (Continued)

```
$

 *******************************************************************
 *                                                                 *
 *  CXTFIT VERSION 2.1 (4/17/99)                                   *
 *  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                   *
 *  NON-LINEAR LEAST-SQUARES ANALYSIS                              *
 *                                                                 *
 *  Comment                                                        *
 *  Comment                                                        *
 *                                                                 *
 *  DATA INPUT FILE: port3in.in                                    *
 *                                                                 *
 *******************************************************************

 MODEL DESCRIPTION
 =================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME     INITIAL VALUE  FITTING
 V.......  .4800E+01     Y
 D.......  .1830E+02     Y
 R.......  .1000E+01     N
 mu......  .0000E+00     N

 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
  SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

 PARAMETER ESTIMATION MODE
 =========================
  MAXIMUM NUMBER OF ITERATIONS =  50

 ITER   SSQ        V.....    D.....
  0  .6410E+00  .480E+01  .183E+02
  1  .5732E+00  .724E+01  .164E+02
  2  .3143E+00  .558E+01  .124E+02
  3  .6775E-01  .617E+01  .711E+01
  4  .3987E-01  .632E+01  .222E+01
  5  .5802E-02  .626E+01  .351E+01
  6  .5547E-02  .625E+01  .366E+01
  7  .5544E-02  .626E+01  .364E+01
  8  .5544E-02  .625E+01  .364E+01
  9  .5544E-02  .625E+01  .364E+01

 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
        V.... D....
  V....  1.000
  D....  -.083  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99347042
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .4265E-03

 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
 ================================================
```

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6255E+01	.2253E-01	.2776E+03	.6206E+01	.6304E+01
D....	.3645E+01	.2168E+00	.1681E+02	.3176E+01	.4113E+01

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	CONCENTRATION FITTED	RESIDUAL
1	86	4.0208	0.0018	0	0.0018
2	86	5.9167	0.0022	0	0.0022
3	86	7.9722	0.0028	0	0.0028
4	86	8.9306	0.0029	0.0001	0.0028
5	86	9.8472	0.0058	0.0019	0.0039
6	86	10.2813	0.012	0.006	0.006
7	86	10.9861	0.0398	0.0263	0.0135
8	86	11.816	0.1185	0.0955	0.023
9	86	12.9167	0.3215	0.2927	0.0288
10	86	13.9514	0.5252	0.5253	-0.0001
11	86	14.8542	0.6411	0.647	-0.0059
12	86	16.0556	0.5944	0.5819	0.0125
13	86	17.0521	0.4449	0.3941	0.0508
14	86	19.0833	0.052	0.0858	-0.0338
15	86	23.7708	0.0034	0.0002	0.0032

Table A-9. Test 1 Port A CXTFIT Data. H) Column 8 (2 pages) (Continued)

```
$

*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: port2in.in                                  *
*                                                               *
*****************************************************************


MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V.......   .4800E+01      Y
D.......   .1830E+02      Y
R.......   .1000E+01      N
mu......   .0000E+00      N


BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =  1.0000 & DURATION =  3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM


PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50


ITER   SSQ        V....    D....
0   .9335E+00  .480E+01  .183E+02
1   .5406E+00  .841E+01  .448E+02
2   .3157E+00  .687E+01  .224E+02
3   .1018E+00  .725E+01  .112E+02
4   .1426E-01  .732E+01  .589E+01
5   .1520E-02  .736E+01  .370E+01
6   .1170E-02  .736E+01  .396E+01
7   .1170E-02  .736E+01  .396E+01


COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
       V....  D....
 V....  1.000
 D....  -.028  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99868099
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .1950E-03


NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                            95% CONFIDENCE LIMITS
NAME    VALUE    S.E.COEFF. T-VALUE   LOWER     UPPER
V....  .7358E+01  .2235E-01 .3293E+03  .7303E+01  .7412E+01
D....  .3965E+01  .2109E+00 .1880E+02  .3449E+01  .4481E+01
```

-----------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	61	1.23	0.0019	0	0.0019
2	61	2.06	0.0018	0	0.0018
3	61	4.02	0.0017	0	0.0017
4	61	5.92	0.0033	0.0053	-0.002
5	61	7.96	0.3883	0.379	0.0093
6	61	8.93	0.6832	0.7071	-0.0239
7	61	9.83	0.8498	0.8299	0.0199
8	61	11.01	0.5769	0.5871	-0.0102

Table A-9. Test 1 Port A CXTFIT Data. I) Column 9 (2 pages) (Continued)

```
$

*******************************************************************
*                                                                 *
*  CXTFIT VERSION 2.1 (4/17/99)                                   *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                   *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                              *
*                                                                 *
*  Comment                                                        *
*  Comment                                                        *
*                                                                 *
*  DATA INPUT FILE: port3in.in                                    *
*                                                                 *
*******************************************************************


 MODEL DESCRIPTION
 =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME      INITIAL VALUE   FITTING
 V.......     .4800E+01     Y
 D.......     .1830E+02     Y
 R.......     .1000E+01     N
 mu......     .0000E+00     N


 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
   SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
   SOLUTE FREE INITIAL CONDITION
   NO PRODUCTION TERM


 PARAMETER ESTIMATION MODE
 =========================
   MAXIMUM NUMBER OF ITERATIONS =  50


 ITER   SSQ        V....     D....
  0  .4780E+00  .480E+01  .183E+02
  1  .3650E+00  .692E+01  .198E+02
  2  .2249E+00  .563E+01  .490E+01
  3  .3771E-01  .621E+01  .765E+01
  4  .6529E-02  .629E+01  .374E+01
  5  .2254E-02  .628E+01  .443E+01
  6  .2215E-02  .628E+01  .451E+01
  7  .2215E-02  .628E+01  .451E+01


 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
          V....   D....
   V....  1.000
   D....  -.083   1.000

   RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99668941
    (COEFFICIENT OF DETERMINATION)

   MEAN SQUARE FOR ERROR (MSE) =   .1846E-03

 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
 ================================================

                                     95% CONFIDENCE LIMITS
 NAME    VALUE    S.E.COEFF  T-VALUE    LOWER      UPPER
 V....  .6279E+01  .1683E-01 .3731E+03  .6242E+01  .6316E+01
 D....  .4507E+01  .1730E+00 .2606E+02  .4130E+01  .4884E+01
```

-----------------ORDERED BY COMPUTER INPUT-----------------

$ NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	86	4.0208	0.0021	0	0.0021
2	86	6.9271	0.002	0	0.002
3	86	8.0069	0.0027	0	0.0027
4	86	8.9201	0.0029	0.0004	0.0025
5	86	9.8368	0.0083	0.0049	0.0034
6	86	10.2847	0.0145	0.0127	0.0018
7	86	10.9896	0.0346	0.0431	-0.0085
8	86	11.8229	0.1077	0.1258	-0.0181
9	86	12.9271	0.3033	0.3204	-0.0171
10	86	13.941	0.511	0.5144	-0.0034
11	86	14.8611	0.6066	0.6055	0.0011
12	86	16.066	0.5055	0.5358	-0.0303
13	86	17.0556	0.3713	0.3767	-0.0054
14	86	19.0868	0.0778	0.1007	-0.0229

Table A-10. Test 1 Port B CXTFIT Data. A) Column 1 (2 pages)

$

```
******************************************************************
*                                                                *
*  CXTFIT VERSION 2.1 (4/17/99)                                  *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                             *
*                                                                *
*  Comment                                                       *
*  Comment                                                       *
*                                                                *
*  DATA INPUT FILE: port4in.in                                   *
*                                                                *
******************************************************************
```

MODEL DESCRIPTION
=================

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
==

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.7474E+00	.480E+01	.183E+02
1	.5608E+00	.724E+01	.536E+02
2	.5227E+00	.541E+01	.268E+02
3	.1882E+00	.665E+01	.134E+02
4	.6292E-01	.644E+01	.670E+01
5	.5509E-01	.649E+01	.455E+01
6	.5210E-01	.649E+01	.528E+01
7	.5205E-01	.648E+01	.518E+01
8	.5204E-01	.648E+01	.520E+01
9	.5204E-01	.648E+01	.520E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================

	V....	D....
V....	1.000	
D....	-.091	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .89835387
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .4731E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
==

			95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6482E+01	.7476E-01	.8671E+02	.6318E+01	.6647E+01
D....	.5203E+01	.9888E+00	.5262E+01	.3027E+01	.7379E+01

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	122	2.0625	0.0019	0	0.0019
2	122	4.9479	0.0021	0	0.0021
3	122	10.8021	0.0029	0	0.0029
4	122	16.0174	0.0816	0.0784	0.0032
5	122	16.816	0.1764	0.1588	0.0176
6	122	17.9792	0.3352	0.3218	0.0134
7	122	18.7813	0.59	0.4312	0.1588
8	122	19.9792	0.5479	0.5155	0.0324
9	122	21.0938	0.4387	0.4756	-0.0369
10	122	21.7604	0.431	0.4093	0.0218
11	122	22.7743	0.3582	0.2853	0.0729
12	122	23.7847	0.272	0.1725	0.0995
13	122	24.7569	0.1847	0.0941	0.0905

(Table continued on next page)

Table A-10. Test 1 Port B CXTFIT Data. B) Column 2 (2 pages) (Continued)

$

```
*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: port4in.in                                  *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V.......	.4800E+01	Y
D.......	.1830E+02	Y
R.......	.1000E+01	N
mu......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V.....	D....
0	.9474E-01	.480E+01	.183E+02
1	.1270E-01	.363E+01	.296E+02
2	.1454E-02	.260E+01	.374E+02
3	.1992E-03	.192E+01	.402E+02
4	.1010E-03	.190E+01	.313E+02
5	.9969E-04	.212E+01	.257E+02
6	.9744E-04	.246E+01	.197E+02
7	.9457E-04	.292E+01	.131E+02
8	.8590E-04	.323E+01	.102E+02
9	.8130E-04	.347E+01	.787E+01
10	.7607E-04	.370E+01	.606E+01
11	.7159E-04	.389E+01	.481E+01
12	.6838E-04	.402E+01	.399E+01
13	.6632E-04	.412E+01	.344E+01
14	.6503E-04	.419E+01	.307E+01
15	.6422E-04	.425E+01	.280E+01
16	.6371E-04	.429E+01	.261E+01
17	.6337E-04	.432E+01	.246E+01
18	.6315E-04	.434E+01	.235E+01
19	.6300E-04	.436E+01	.226E+01
20	.6290E-04	.438E+01	.219E+01
21	.6283E-04	.439E+01	.213E+01
22	.6278E-04	.440E+01	.208E+01
23	.6275E-04	.441E+01	.205E+01
24	.6272E-04	.442E+01	.201E+01
25	.6270E-04	.443E+01	.199E+01
26	.6269E-04	.443E+01	.197E+01
27	.6268E-04	.444E+01	.195E+01
28	.6267E-04	.444E+01	.193E+01

29	.6267E-04	.444E+01	.192E+01
30	.6266E-04	.445E+01	.191E+01
31	.6266E-04	.445E+01	.190E+01
32	.6266E-04	.445E+01	.189E+01
33	.6266E-04	.446E+01	.186E+01
34	.6266E-04	.446E+01	.184E+01
35	.6265E-04	.446E+01	.184E+01
36	.6265E-04	.446E+01	.184E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.998	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .48531752
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .8950E-05

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.4464E+01	.4345E+00	.1027E+02	.3437E+01	.5491E+01
D....	.1839E+01	.2015E+01	.9129E+00	-.2924E+01	.6603E+01

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	122	4.9688	0.0019	0	0.0019
2	122	16.0417	0.005	0	0.005
3	122	16.8333	0.003	0	0.003
4	122	18.0035	0.0042	0	0.0042
5	122	19.0625	0.002	0	0.002
6	122	20.0104	0.0016	0.0001	0.0016
7	122	21.1146	0.0018	0.0008	0.001
8	122	21.7604	0.002	0.0027	-0.0007
9	122	22.816	0.0138	0.0137	0.0001

Table A-10. Test 1 Port B CXTFIT Data. C) Column 3 (2 pages) (Continued)

```
$
*************************************************************
*     CXTFIT VERSION 2.1 (4/17/99)                           *
*     ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE            *
*     NON-LINEAR LEAST-SQUARES ANALYSIS                       *
*                                                             *
*     Comment                                                 *
*     Comment                                                 *
*                                                             *
*     DATA INPUT FILE: port4in.in                             *
*                                                             *
*************************************************************

MODEL DESCRIPTION
=================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME     INITIAL VALUE   FITTING
V.....    .4800E+01        Y
D.....    .1830E+02        Y
R.....    .1000E+01        N
mu....    .0000E+00        N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
MAXIMUM NUMBER OF ITERATIONS =  50

ITER    SSQ        V..        D..
 0   .2363E+00  .480E+01  .183E+02
 1   .2181E+00  .640E+01  .347E+01
 2   .3550E-01  .613E+01  .662E+01
 3   .5114E-02  .586E+01  .745E+01
 4   .3623E-02  .583E+01  .669E+01
 5   .3610E-02  .584E+01  .671E+01
 6   .3610E-02  .584E+01  .671E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
      V...    D...
V..   1.000
D..   -.109   1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .98859508
 (COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) =  .3610E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================
                                     95% CONFIDENCE LIMITS
NAME     VALUE     S.E.COEFF.  T-VALUE    LOWER      UPPER
V...   .5840E+01  .3143E-01  .1858E+03  .5770E+01  .5910E+01
D...   .6710E+01  .3765E+00  .1782E+02  .5871E+01  .7549E+01
```

----------------ORDERED BY COMPUTER INPUT----------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	122	0.8958	0.0016	0	0.0016
2	122	4.8958	0.0012	0	0.0012
3	122	11.309	0.0019	0	0.0019
4	122	15.9826	0.023	0.0244	-0.0014
5	122	16.8125	0.0439	0.0544	-0.0105
6	122	17.9688	0.0926	0.1276	-0.035
7	122	18.7813	0.1977	0.198	-0.0003
8	122	19.9792	0.3175	0.3077	0.0098
9	122	21.0972	0.3707	0.3822	-0.0115
10	122	21.7604	0.416	0.4019	0.0141
11	122	22.7574	0.392	0.3928	-0.0008
12	122	23.8264	0.2985	0.3413	-0.0429

Table A-10. Test 1 Port B CXTFIT Data. D) Column 4 (2 pages) (Continued)

```
$
     ***************************************************************
     *    CXTFIT VERSION 2.1 (4/17/99)                             *
     *    ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE             *
     *    NON-LINEAR LEAST-SQUARES ANALYSIS                        *
     *                                                             *
     *    Comment                                                  *
     *    Comment                                                  *
     *                                                             *
     *    DATA INPUT FILE:  port4in.in                             *
     *                                                             *
     ***************************************************************

     MODEL DESCRIPTION
     =================
       DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
       RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
       REAL TIME (t), POSITION(x)
        (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

     INITIAL VALUES OF COEFFICIENTS
     ==============================
     NAME     INITIAL VALUE  FITTING
     V.......   .4800E+01     Y
     D.......   .1830E+02     Y
     R.......   .1000E+01     N
     mu......   .0000E+00     N

     BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
     ============================================
     SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
     SOLUTE FREE INITIAL CONDITION
     NO PRODUCTION TERM

     PARAMETER ESTIMATION MODE
     =========================
     MAXIMUM NUMBER OF ITERATIONS =   50

     ITER   SSQ        V..       D...
      0  .1585E+00  .480E+01  .183E+02
      1  .6710E-01  .512E+01  .915E+01
      2  .4673E-01  .531E+01  .402E+01
      3  .3652E-01  .534E+01  .536E+01
      4  .3640E-01  .533E+01  .547E+01
      5  .3639E-01  .532E+01  .548E+01
      6  .3639E-01  .532E+01  .549E+01
      7  .3639E-01  .532E+01  .549E+01

     COVARIANCE MATRIX FOR FITTED PARAMETERS
     =======================================
           V...   D...
     V..  1.000
     D...  .030  1.000

     RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .76423879
     (COEFFICIENT OF DETERMINATION)

     MEAN SQUARE FOR ERROR (MSE) =  .7278E-02

     NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
     ================================================
                                       95% CONFIDENCE LIMITS
     NAME   VALUE     S.E.COEFF.  T-VALUE    LOWER      UPPER
     V...  .5325E+01  .1255E+00  .4241E+02  .5002E+01  .5647E+01
     D...  .5487E+01  .1569E+01  .3498E+01  .1455E+01  .9519E+01
```

----------------ORDERED BY COMPUTER INPUT-----------------

$

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	122	19.0729	0.0067	0.0749	-0.0682
2	122	20.0069	0.0893	0.1367	-0.0473
3	122	21.1215	0.1943	0.2299	-0.0356
4	122	22.0486	0.3448	0.3066	0.0382
5	122	22.8472	0.4152	0.3577	0.0575
6	122	23.875	0.4229	0.3889	0.034
7	122	24.7847	0.2305	0.3798	-0.1494

Table A-10. Test 1 Port B CXTFIT Data. E) Column 5 (2 pages) (Continued)

```
$
 ***************************************************************
 *                                                             *
 *   CXTFIT VERSION 2.1 (4/17/99)                              *
 *   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE               *
 *   NON-LINEAR LEAST-SQUARES ANALYSIS                         *
 *                                                             *
 *   Comment                                                   *
 *   Comment                                                   *
 *                                                             *
 *   DATA INPUT FILE: port4in in                               *
 *                                                             *
 ***************************************************************

 MODEL DESCRIPTION
 =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME       INITIAL VALUE  FITTING
 V.....      .4800E+01      Y
 D.....      .1830E+02      Y
 R.....      .1000E+01      N
 mu....      .0000E+00      N

 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
 SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

 PARAMETER ESTIMATION MODE
 =========================
 MAXIMUM NUMBER OF ITERATIONS =  50

 ITER   SSQ        V...      D...
 0   .8162E-01  .480E+01  .183E+02
 1   .5230E-01  .461E+01  .915E+01
 2   .2565E-01  .482E+01  .458E+01
 3   .9149E-02  .492E+01  .229E+01
 4   .4884E-02  .506E+01  .559E+00
 5   .3566E-03  .504E+01  .987E+00
 6   .3925E-04  .504E+01  .111E+01
 7   .3779E-04  .504E+01  .111E+01
 8   .3779E-04  .504E+01  .112E+01

 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
        V...   D...
 V...   1.000
 D...   -.728  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99968378
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .9447E-05

 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
 ================================================
```

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.5040E+01	.2927E-02	.1722E+04	.5032E+01	.5048E+01
D....	.1115E+01	.3447E-01	.3236E+02	.1020E+01	.1211E+01

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	122	17.9688	0.0041	0	0.0041
2	122	18.8056	0.002	0	0.002
3	122	21.1076	0.015	0.0113	0.0037
4	122	21.7674	0.0369	0.0386	-0.0018
5	122	22.8646	0.1709	0.1709	0
6	122	23.8299	0.3907	0.3907	0.0001

Table A-10. Test 1 Port B CXTFIT Data. F) Column 6 (2 pages) (Continued)

```
$
**************************************************************
*   CXTFIT VERSION 2.1 (4/17/99)                             *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE             *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                        *
*                                                            *
*   Comment                                                  *
*   Comment                                                  *
*                                                            *
*   DATA INPUT FILE:  port4in.in                             *
*                                                            *
**************************************************************

 MODEL DESCRIPTION
 =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME       INITIAL VALUE  FITTING
 V.......   .4800E+01      Y
 D.......   .1830E+02      Y
 R.......   .1000E+01      N
 mu......   .0000E+00      N

 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
 SINGLE PULSE OF CONC. =    1.0000 & DURATION =    3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

 PARAMETER ESTIMATION MODE
 =========================
 MAXIMUM NUMBER OF ITERATIONS =   50

 ITER    SSQ        V...      D...
   0   .2743E+00  .480E+01  .183E+02
   1   .4478E-01  .565E+01  .999E+01
   2   .1244E-01  .587E+01  .496E+01
   3   .8899E-02  .584E+01  .574E+01
   4   .8806E-02  .584E+01  .589E+01
   5   .8805E-02  .584E+01  .590E+01
   6   .8805E-02  .584E+01  .590E+01

 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
        V...    D...
 V...   1.000
 D...   -.130   1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .97131322
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .9784E-03

 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
 ================================================
                                          95% CONFIDENCE LIMITS
 NAME     VALUE     S.E.COEFF.  T-VALUE     LOWER      UPPER
 V...   .5836E+01  .4730E-01  .1234E+03  .5729E+01  .5943E+01
 D...   .5901E+01  .5349E+00  .1103E+02  .4691E+01  .7111E+01
```

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	122	4.9688	0.0019	0	0.0019
2	122	10.8194	0.0032	0	0.0032
3	122	16	0.0384	0.0181	0.0203
4	122	16.8333	0.0674	0.0446	0.0228
5	122	17.9861	0.1061	0.1156	-0.0095
6	122	19.0625	0.1762	0.216	-0.0398
7	122	20.0799	0.311	0.3194	-0.0084
8	122	21.125	0.3929	0.3998	-0.0069
9	122	22.0208	0.4581	0.4269	0.0312
10	122	22.8542	0.4302	0.4129	0.0173
11	122	23.8819	0.2849	0.3541	-0.0692

Table A-10. Test 1 Port B CXTFIT Data. G) Column 7 (2 pages) (Continued)

```
$
  *******************************************************************
  *     CXTFIT VERSION 2.1 (4/17/99)                                *
  *     ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
  *     NON-LINEAR LEAST-SQUARES ANALYSIS                           *
  *                                                                 *
  *     Comment                                                     *
  *     Comment                                                     *
  *                                                                 *
  *     DATA INPUT FILE:  port4in.in                                *
  *                                                                 *
  *******************************************************************

  MODEL DESCRIPTION
  =================
    DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
    RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
    REAL TIME (t), POSITION(x)
     (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

  INITIAL VALUES OF COEFFICIENTS
  ==============================
  NAME      INITIAL VALUE   FITTING
  V.......   .4800E+01        Y
  D.......   .1830E+02        Y
  R.......   .1000E+01        N
  mu......   .0000E+00        N

  BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
  ===========================================
  SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

  PARAMETER ESTIMATION MODE
  =========================
  MAXIMUM NUMBER OF ITERATIONS =  100

  ITER   SSQ        V...      D...
  0   .1071E+00  .480E+01  .183E+02
  1   .7705E-01  .486E+01  .915E+01
  2   .3364E-01  .513E+01  .458E+01
  3   .1014E-01  .522E+01  .229E+01
  4   .8073E-02  .532E+01  .668E+00
  5   .1935E-02  .530E+01  .118E+01
  6   .1774E-02  .530E+01  .122E+01
  7   .1773E-02  .530E+01  .122E+01
  8   .1773E-02  .530E+01  .122E+01
  9   .1773E-02  .530E+01  .122E+01

  COVARIANCE MATRIX FOR FITTED PARAMETERS
  =======================================
          V...   D...
  V...   1.000
  D...   -.616  1.000

  RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .98812993
   (COEFFICIENT OF DETERMINATION)

  MEAN SQUARE FOR ERROR (MSE) =   .5910E-03

  NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
  ================================================
```

NAME	VALUE	S.E.COEFF.	T-VALUE	95% CONFIDENCE LIMITS LOWER	UPPER
V....	.5302E+01	.1950E-01	.2719E+03	.5240E+01	.5365E+01
D....	.1219E+01	.2497E+00	.4883E+01	.4247E+00	.2014E+01

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	122	18.8056	0.0023	0.0005	0.0018
2	122	20	0.0058	0.0111	-0.0053
3	122	21.1111	0.0523	0.0802	-0.0279
4	122	22.0313	0.2673	0.2386	0.0286
5	122	22.8646	0.439	0.4511	-0.0121

Table A-10. Test 1 Port B CXTFIT Data. H) Column 8 (2 pages) (Continued)

```
$
   *******************************************************************
*       CXTFIT VERSION 2.1 (4/17/99)                *
*       ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE        *
*       NON-LINEAR LEAST-SQUARES ANALYSIS                   *
*
*       Comment                                      *
*       Comment                                      *
*                                                    *
*       DATA INPUT FILE:  port4in in                 *
*                                                    *
*******************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V..	.4800E+01	Y
D......	.1830E+02	Y
R......	.1000E+01	N
mu.....	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V..	D..
0	.6415E+00	.480E+01	.183E+02
	.5386E+00	.780E+01	.527E+02
1	.4842E+00	.585E+01	.395E+02
2	.2814E+00	.651E+01	.198E+02
3	.1852E+00	.601E+01	.988E+01
4	.4986E-01	.636E+01	.549E+01
5	.2064E-01	.636E+01	.259E+01
6	.1836E-01	.637E+01	.295E+01
7	.1829E-01	.638E+01	.302E+01
8	.1829E-01	.637E+01	.303E+01
10 9	.1829E-01	.637E+01	.303E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V...	D..
V..	1.000	
D...	-.018	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .72736432
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = 9146E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

NAME	VALUE	S.E.COEFF.	T-VALUE	95% CONFIDENCE LIMITS	
				LOWER	UPPER
V...	.6375E+01	.1077E+00	.5919E+02	.5911E+01	.6838E+01
D...	.3033E+01	.9224E+00	.3288E+01	-.9365E+00	.7002E+01

-----------------ORDERED BY COMPUTER INPUT-----------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	122	19.066	0.3663	0.4595	-0.0932
2	122	20	0.652	0.6021	0.0499
3	122	21.1042	0.6154	0.6022	0.0132
4	122	22.0347	0.3864	0.4697	-0.0833

Table A-10. Test 1 Port B CXTFIT Data. I) Column 9 (2 pages) (Continued)

```
$
*****************************************************************
*      CXTFIT VERSION 2.1 (4/17/99)                              *
*      ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE              *
*      NON-LINEAR LEAST-SQUARES ANALYSIS                         *
*                                                                *
*      Comment                                                   *
*      Comment                                                   *
*                                                                *
*      DATA INPUT FILE:  port4in.in                              *
*                                                                *
*****************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE   FITTING
V........   .4800E+01
D........   .1830E+02      Y
R........   .1000E+01      Y
mu.......   .0000E+00      N
                           N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
MAXIMUM NUMBER OF ITERATIONS =   50

ITER   SSQ        V...       D...
  .2730E+00   .480E+01   .183E+02
0 .4651E-01   .556E+01   .938E+01
1 .1169E-01   .578E+01   .460E+01
2 .7987E-02   .575E+01   .531E+01
3 .7910E-02   .575E+01   .544E+01
4 .7910E-02   .575E+01   .545E+01
5 .7910E-02   .575E+01   .545E+01
6

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
       V...   D...
V..    1.000
D...   -.159  1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = 97666430
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) =   7910E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                                      95% CONFIDENCE LIMITS
NAME    VALUE      S.E.COEFF.  T-VALUE     LOWER       UPPER
V..   .5745E+01   .3862E-01   .1488E+03   .5659E+01   .5831E+01
D..   .5446E+01   .4362E+00   .1249E+02   .4474E+01   .6418E+01
```

------------------ORDERED BY COMPUTER INPUT------------------

$

NO	DISTANCE	TIME	CONCENTRATION OBS	CONCENTRATION FITTED	RESI-DUAL
1	122	4.875	0.002	0	0.002
2	122	10.8229	0.003	0	0.003
3	122	15.9931	0.0222	0.011	0.0113
4	122	16.8229	0.0441	0.0298	0.0143
5	122	18	0.0838	0.0889	-0.005
6	122	18.7986	0.1511	0.1546	-0.0035
7	122	20.0799	0.2629	0.2866	-0.0238
8	122	21.1076	0.3456	0.3811	-0.0355
9	122	22.0139	0.447	0.4274	0.0196
10	122	22.7847	0.45	0.4303	0.0197
11	122	23.8472	0.397	0.3841	0.0129
12	122	24.7743	0.244	0.313	-0.069

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. A) Column 1 (2 pages)

```
C0=1.0

 *****************************************************************
 *                                     *
 *   CXTFIT VERSION 2.1 (4/17/99)              *
 *   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE          *
 *   NON-LINEAR LEAST-SQUARES ANALYSIS              *
 *                                     *
 *   Comment                           *
 *   Comment                           *
 *                                     *
 *   DATA INPUT FILE:  inverse.in               *
 *                                     *
 *****************************************************************


  MODEL DESCRIPTION
  =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


  INITIAL VALUES OF COEFFICIENTS
  ==============================
  NAME     INITIAL VALUE  FITTING
  V........   .4800E+01     Y
  D........   .1830E+02     Y
  R........   .1000E+01     N
  mu.......   .0000E+00     N


  BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
  ============================================
   SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
   SOLUTE FREE INITIAL CONDITION
   NO PRODUCTION TERM


  PARAMETER ESTIMATION MODE
  =========================
   MAXIMUM NUMBER OF ITERATIONS =  50

  ITER   SSQ        V....      D....
   0  .2802E+00  .480E+01  .183E+02
   1  .2090E+00  .493E+01  .355E+02
   2  .1917E+00  .491E+01  .518E+02
   3  .1804E+00  .479E+01  .705E+02
   4  .1732E+00  .463E+01  .919E+02
   5  .1695E+00  .448E+01  .113E+03
   6  .1681E+00  .435E+01  .129E+03
   7  .1677E+00  .427E+01  .138E+03
   8  .1676E+00  .423E+01  .143E+03
   9  .1675E+00  .421E+01  .146E+03
  10  .1675E+00  .420E+01  .147E+03
  11  .1675E+00  .420E+01  .147E+03
  12  .1675E+00  .419E+01  .147E+03
  13  .1675E+00  .419E+01  .148E+03
  14  .1675E+00  .419E+01  .148E+03


  COVARIANCE MATRIX FOR FITTED PARAMETERS
  =======================================
         V....  D....
   V....  1.000
   D....   .506  1.000

   RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .10544663
   (COEFFICIENT OF DETERMINATION)

  MEAN SQUARE FOR ERROR (MSE) =   .2939E-02


 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
```

==

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.4192E+01	.5888E+00	.7121E+01	.3013E+01	.5371E+01
D....	.1476E+03	.7569E+02	.1951E+01	-.3938E+01	.2992E+03

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	193.6	0.8958	0.0033	0	0.0033
2	193.6	4.0208	0.0019	0	0.0019
3	193.6	10.8264	0.0024	0.0023	0.0001
4	193.6	14.8715	0.0024	0.0115	-0.0091
5	193.6	18.0069	0.0031	0.0221	-0.019
6	193.6	21.7778	0.0019	0.0345	-0.0326
7	193.6	24.7569	0.002	0.0424	-0.0404
8	193.6	25.7882	0.0018	0.0446	-0.0427
9	193.6	26.8021	0.0022	0.0465	-0.0442
10	193.6	27.0868	0.0022	0.047	-0.0447
11	193.6	27.8785	0.0023	0.0482	-0.0459
12	193.6	28.1528	0.0027	0.0486	-0.0459
13	193.6	28.75	0.0029	0.0494	-0.0466
14	193.6	29.1076	0.0037	0.0499	-0.0461
15	193.6	29.7292	0.0057	0.0505	-0.0448
16	193.6	30.3229	0.0092	0.0511	-0.0419
17	193.6	30.75	0.0123	0.0515	-0.0392
18	193.6	31.0972	0.0163	0.0518	-0.0355
19	193.6	31.7639	0.0289	0.0522	-0.0233
20	193.6	32.1007	0.041	0.0524	-0.0114
21	193.6	32.7465	0.068	0.0527	0.0153
22	193.6	33.0451	0.0833	0.0529	0.0305
23	193.6	33.8264	0.1207	0.0531	0.0676
24	193.6	34.1493	0.136	0.0532	0.0829
25	193.6	34.7292	0.1628	0.0532	0.1096
26	193.6	35.0833	0.1743	0.0533	0.1211
27	193.6	35.6771	0.1839	0.0533	0.1306
28	193.6	36.1285	0.1818	0.0532	0.1286
29	193.6	36.7917	0.1638	0.0531	0.1106
30	193.6	37.1285	0.1508	0.0531	0.0977
31	193.6	37.8125	0.1232	0.0529	0.0703
32	193.6	38.125	0.1057	0.0528	0.053
33	193.6	38.8785	0.0791	0.0525	0.0266
34	193.6	39.1424	0.0642	0.0524	0.0118
35	193.6	39.7882	0.0354	0.0521	-0.0166
36	193.6	40.191	0.0241	0.0519	-0.0277
37	193.6	40.8611	0.0111	0.0515	-0.0404
38	193.6	41.1736	0.0082	0.0513	-0.0431
39	193.6	41.8646	0.0052	0.0509	-0.0457
40	193.6	42.2778	0.004	0.0506	-0.0466
41	193.6	42.8194	0.003	0.0502	-0.0472
42	193.6	44.0556	0.0022	0.0493	-0.047
43	193.6	44.8264	0.0025	0.0486	-0.0461
44	193.6	45.8194	0.0021	0.0478	-0.0457
45	193.6	47.0903	0.0025	0.0466	-0.0442
46	193.6	47.8438	0.0021	0.046	-0.0439
47	193.6	48.8993	0.0024	0.045	-0.0425
48	193.6	49.816	0.0022	0.0441	-0.0419
49	193.6	50.8472	0.0018	0.0431	-0.0412
50	193.6	51.8576	0.0018	0.0421	-0.0403
51	193.6	52.8333	0.0018	0.0411	-0.0393
52	193.6	53.8021	0.0015	0.0401	-0.0386
53	193.6	54.8576	0.0016	0.0391	-0.0375
54	193.6	55.8576	0.0014	0.0381	-0.0367
55	193.6	56.7778	0.0017	0.0372	-0.0355
56	193.6	57.8438	0.0017	0.0361	-0.0344
57	193.6	58.8646	0.0017	0.0351	-0.0335
58	193.6	59.8333	0.0017	0.0342	-0.0325
59	193.6	60.8125	0.0015	0.0333	-0.0318

(Table continued on next page)

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. B) Column 2 (2 pages) (Continued)

```
C0=1.0

*****************************************************************
*     CXTFIT VERSION 2.1 (4/17/99)                              *
*     ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE              *
*     NON-LINEAR LEAST-SQUARES ANALYSIS                         *
*                                                               *
*     Comment                                                   *
*     Comment                                                   *
*                                                               *
*     DATA INPUT FILE:  inverse.in                              *
*                                                               *
*****************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
  (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME       INITIAL VALUE   FITTING
V.......   .4800E+01        Y
D.......   .1830E+02        Y
R.......   .1000E+01        N
mu......   .0000E+00        N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
  SINGLE PULSE OF CONC. =    1.0000 & DURATION =    3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
  MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ       V...      D..
 0   .4430E+00  .480E+01  .183E+02
 1   .1817E+00  .421E+01  .409E+02
 2   .5914E-01  .312E+01  .735E+02
 3   .4216E-01  .239E+01  .578E+02
 4   .4197E-01  .247E+01  .489E+02
 5   .4196E-01  .248E+01  .509E+02
 6   .4196E-01  .249E+01  .493E+02
 7   .4195E-01  .249E+01  .502E+02
 8   .4195E-01  .249E+01  .500E+02
 9   .4195E-01  .249E+01  .500E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V...    D..
V..    1.000
D..    -.465   1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .21350556
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) =  .6555E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================
                                        95% CONFIDENCE LIMITS
NAME    VALUE      S.E.COEFF.  T-VALUE     LOWER       UPPER
V...  .2488E+01   .1580E+00   .1575E+02   .2172E+01   .2803E+01
D...  .4996E+02   .1662E+02   .3006E+01   .1675E+02   .8317E+02
```

-----------------ORDERED BY COMPUTER INPUT------------------

$ NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI- DUAL
1	192.1	4.0208	0.0017	0	0.0017
2	192.1	10.8333	0.0075	0	0.0075
3	192.1	14.8819	0.0024	0	0.0024
4	192.1	18.0139	0.0031	0.0001	0.003
5	192.1	21.7778	0.0019	0.0008	0.0011
6	192.1	25.125	0.0017	0.0022	-0.0005
7	192.1	25.8264	0.0018	0.0027	-0.0009
8	192.1	26.8125	0.0021	0.0034	-0.0013
9	192.1	27.0972	0.0022	0.0036	-0.0014
10	192.1	27.8889	0.0023	0.0043	-0.002
11	192.1	28.1597	0.0023	0.0045	-0.0022
12	192.1	28.7604	0.0023	0.005	-0.0027
13	192.1	29.1181	0.0023	0.0054	-0.0031
14	192.1	29.7396	0.0026	0.006	-0.0034
15	192.1	30.3333	0.0027	0.0067	-0.004
16	192.1	30.7639	0.0025	0.0071	-0.0046
17	192.1	31.1042	0.0025	0.0075	-0.005
18	192.1	31.7743	0.0025	0.0083	-0.0058
19	192.1	32.1111	0.0026	0.0087	-0.0061
20	192.1	32.7569	0.0028	0.0095	-0.0067
21	192.1	33.0556	0.003	0.0099	-0.0069
22	192.1	33.8333	0.0033	0.0109	-0.0076
23	192.1	34.1597	0.0034	0.0113	-0.0079
24	192.1	34.7361	0.002	0.0121	-0.0101
25	192.1	35.0903	0.002	0.0126	-0.0106
26	192.1	35.6875	0.0023	0.0134	-0.0111
27	192.1	36.1354	0.0019	0.0141	-0.0122
28	192.1	36.7986	0.0023	0.015	-0.0127
29	192.1	37.1354	0.0022	0.0155	-0.0133
30	192.1	37.8229	0.0021	0.0165	-0.0144
31	192.1	38.1354	0.0022	0.0169	-0.0147
32	192.1	38.8889	0.0022	0.018	-0.0158
33	192.1	39.1528	0.002	0.0184	-0.0164
34	192.1	39.7986	0.0019	0.0193	-0.0174
35	192.1	40.1979	0.002	0.0198	-0.0178
36	192.1	40.8681	0.0023	0.0208	-0.0185
37	192.1	41.184	0.0022	0.0212	-0.019
38	192.1	41.875	0.0025	0.0222	-0.0197
39	192.1	42.2847	0.0032	0.0228	-0.0196
40	192.1	42.8264	0.0046	0.0235	-0.0189
41	192.1	44.0625	0.0171	0.0251	-0.008
42	192.1	44.8333	0.0352	0.0261	0.0091
43	192.1	45.0868	0.0448	0.0264	0.0184
44	192.1	45.8264	0.068	0.0273	0.0407
45	192.1	46.7917	0.0933	0.0285	0.0648
46	192.1	47.0972	0.101	0.0288	0.0722
47	192.1	47.8507	0.105	0.0297	0.0753
48	192.1	48.1806	0.0912	0.03	0.0612
49	192.1	48.9063	0.0829	0.0308	0.0521
50	192.1	49.1771	0.073	0.031	0.042
51	192.1	49.8229	0.0634	0.0317	0.0317
52	192.1	50.0521	0.056	0.0319	0.0241
53	192.1	50.8542	0.0509	0.0326	0.0183
54	192.1	51.8646	0.0455	0.0335	0.012
55	192.1	52.8403	0.033	0.0343	-0.0013
56	192.1	53.0938	0.0301	0.0345	-0.0044
57	192.1	53.809	0.0244	0.035	-0.0106
58	192.1	54.8646	0.0121	0.0357	-0.0236
59	192.1	55.1563	0.0101	0.0359	-0.0258
60	192.1	55.8646	0.0054	0.0363	-0.0309
61	192.1	56.0903	0.004	0.0364	-0.0324
62	192.1	56.7847	0.0026	0.0368	-0.0342
63	192.1	57.8507	0.0017	0.0373	-0.0356
64	192.1	58.8715	0.0016	0.0377	-0.0361
65	192.1	59.8403	0.0017	0.038	-0.0363
66	192.1	60.8194	0.0015	0.0383	-0.0367

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. C) Column 3 (2 pages) (Continued)

C0=1.0

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: inverse in                                 *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.4528E+00	.480E+01	.183E+02
1	.2920E+00	.499E+01	.468E+02
2	.2631E+00	.521E+01	.831E+02
3	.2544E+00	.531E+01	.121E+03
4	.2505E+00	.522E+01	.155E+03
5	.2493E+00	.513E+01	.177E+03
6	.2489E+00	.503E+01	.189E+03
7	.2488E+00	.498E+01	.196E+03
8	.2488E+00	.495E+01	.199E+03
9	.2488E+00	.493E+01	.201E+03
10	.2488E+00	.492E+01	.202E+03
11	.2488E+00	.492E+01	.202E+03
12	.2488E+00	.492E+01	.202E+03
13	.2488E+00	.492E+01	.202E+03

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	.591	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .08402372
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .4442E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.4917E+01	.1066E+01	.4615E+01	.2783E+01	.7052E+01
D....	.2022E+03	.1189E+03	.1701E+01	-.3588E+02	.4403E+03

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	CONCENTRATION FITTED	RESIDUAL
1	193.5	4.0208	0.0014	0	0.0014
2	193.5	10.8299	0.0022	0.009	-0.0068
3	193.5	14.8889	0.002	0.027	-0.025
4	193.5	18.0104	0.0022	0.0405	-0.0383
5	193.5	21.7813	0.0013	0.052	-0.0507
6	193.5	24.7917	0.0012	0.0571	-0.0559
7	193.5	25.8125	0.0013	0.0582	-0.0569
8	193.5	26.8056	0.0016	0.0589	-0.0573
9	193.5	27.0903	0.0016	0.059	-0.0574
10	193.5	27.8854	0.0021	0.0593	-0.0572
11	193.5	28.1563	0.0025	0.0594	-0.0569
12	193.5	28.7535	0.004	0.0595	-0.0555
13	193.5	29.1146	0.0062	0.0595	-0.0533
14	193.5	29.7326	0.0114	0.0595	-0.0481
15	193.5	30.3264	0.0251	0.0594	-0.0343
16	193.5	30.7535	0.039	0.0593	-0.0203
17	193.5	31.1007	0.0601	0.0591	0.0009
18	193.5	31.7674	0.116	0.0589	0.0571
19	193.5	32.1042	0.1483	0.0587	0.0896
20	193.5	32.75	0.2091	0.0583	0.1508
21	193.5	33.0486	0.2281	0.0581	0.17
22	193.5	33.8299	0.2452	0.0576	0.1876
23	193.5	34.1528	0.2338	0.0574	0.1765
24	193.5	34.7326	0.2015	0.0569	0.1446
25	193.5	35.0868	0.1738	0.0566	0.1172
26	193.5	35.6806	0.1179	0.0561	0.0618
27	193.5	36.1319	0.0827	0.0556	0.0271
28	193.5	36.7951	0.0416	0.055	-0.0134
29	193.5	37.1319	0.0302	0.0547	-0.0244
30	193.5	37.8194	0.0163	0.0539	-0.0376
31	193.5	38.1285	0.0118	0.0536	-0.0418
32	193.5	38.8819	0.0063	0.0528	-0.0465
33	193.5	39.1458	0.0057	0.0525	-0.0468
34	193.5	39.7917	0.0042	0.0518	-0.0475
35	193.5	40.1944	0.0036	0.0513	-0.0477
36	193.5	40.8646	0.003	0.0505	-0.0475
37	193.5	41.1806	0.0027	0.0501	-0.0475
38	193.5	41.8715	0.0025	0.0493	-0.0468
39	193.5	42.2813	0.0024	0.0488	-0.0464
40	193.5	42.8229	0.0024	0.0481	-0.0457
41	193.5	44.066	0.0021	0.0466	-0.0445
42	193.5	44.8333	0.0029	0.0457	-0.0428
43	193.5	45.8264	0.0023	0.0445	-0.0422
44	193.5	47.0972	0.0025	0.0429	-0.0404
45	193.5	47.8507	0.0022	0.042	-0.0398
46	193.5	48.9063	0.0025	0.0407	-0.0382
47	193.5	49.8229	0.0021	0.0396	-0.0375
48	193.5	50.8542	0.0019	0.0384	-0.0365
49	193.5	51.8681	0.0018	0.0372	-0.0354
50	193.5	52.8403	0.0017	0.0361	-0.0344
51	193.5	53.809	0.0016	0.035	-0.0334
52	193.5	54.8646	0.0017	0.0338	-0.0322
53	193.5	55.8681	0.0015	0.0328	-0.0313
54	193.5	56.7847	0.0017	0.0318	-0.0301
55	193.5	57.8507	0.0016	0.0307	-0.0291
56	193.5	58.8715	0.0017	0.0297	-0.028
57	193.5	59.8403	0.0016	0.0287	-0.0271
58	193.5	60.8194	0.0015	0.0278	-0.0263

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. D) Column 4 (2 pages) (Continued)

C0=1.0

```
*********************************************************************
*                                                    *
*   CXTFIT VERSION 2.1 (4/17/99)                            *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                       *
*                                                    *
*   Comment                                           *
*   Comment                                           *
*                                                    *
*   DATA INPUT FILE:  inverse.in                          *
*                                                    *
*********************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.3166E+00	.480E+01	.183E+02
1	.1754E+00	.485E+01	.433E+02
2	.1284E+00	.487E+01	.854E+02
3	.1091E+00	.485E+01	.148E+03
4	.1025E+00	.470E+01	.212E+03
5	.1006E+00	.446E+01	.248E+03
6	.1003E+00	.431E+01	.262E+03
7	.1003E+00	.426E+01	.267E+03
8	.1003E+00	.425E+01	.269E+03
9	.1003E+00	.424E+01	.270E+03
10	.1003E+00	.424E+01	.270E+03
11	.1003E+00	.424E+01	.270E+03

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	.679	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .12373676
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .1759E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.4239E+01	.8100E+00	.5234E+01	.2617E+01	.5861E+01
D....	.2698E+03	.1432E+03	.1884E+01	-.1693E+02	.5565E+03

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	192.2	0.896	0.0018	0	0.0018
2	192.2	4.021	0.0015	0	0.0014
3	192.2	10.83	0.0026	0.012	-0.0094
4	192.2	14.875	0.0033	0.0264	-0.0231
5	192.2	18.01	0.003	0.0352	-0.0321
6	192.2	21.785	0.0022	0.0418	-0.0396
7	192.2	25.122	0.0022	0.0447	-0.0425
8	192.2	25.823	0.0022	0.045	-0.0428
9	192.2	26.809	0.0025	0.0454	-0.0428
10	192.2	27.094	0.003	0.0454	-0.0425
11	192.2	27.889	0.0051	0.0456	-0.0404
12	192.2	28.16	0.0062	0.0456	-0.0394
13	192.2	28.757	0.0123	0.0456	-0.0333
14	192.2	29.118	0.0179	0.0456	-0.0277
15	192.2	29.736	0.028	0.0456	-0.0176
16	192.2	30.33	0.047	0.0455	0.0015
17	192.2	30.76	0.0596	0.0454	0.0142
18	192.2	31.104	0.0768	0.0454	0.0314
19	192.2	31.771	0.107	0.0452	0.0619
20	192.2	32.108	0.1208	0.0451	0.0757
21	192.2	32.753	0.1345	0.0449	0.0896
22	192.2	33.052	0.1419	0.0448	0.0971
23	192.2	33.833	0.1425	0.0444	0.098
24	192.2	34.156	0.1383	0.0443	0.094
25	192.2	34.736	0.1255	0.044	0.0815
26	192.2	35.09	0.1149	0.0439	0.071
27	192.2	35.684	0.0928	0.0436	0.0492
28	192.2	36.132	0.0779	0.0433	0.0346
29	192.2	36.799	0.0571	0.043	0.0142
30	192.2	37.132	0.0478	0.0428	0.005
31	192.2	37.819	0.039	0.0424	-0.0033
32	192.2	38.132	0.0364	0.0422	-0.0058
33	192.2	38.885	0.0286	0.0417	-0.0131
34	192.2	39.149	0.0257	0.0415	-0.0158
35	192.2	39.795	0.0259	0.0411	-0.0152
36	192.2	40.198	0.0234	0.0409	-0.0174
37	192.2	40.868	0.0137	0.0404	-0.0268
38	192.2	41.184	0.0124	0.0402	-0.0278
39	192.2	41.872	0.01	0.0397	-0.0297
40	192.2	42.281	0.0087	0.0395	-0.0308
41	192.2	42.826	0.0059	0.0391	-0.0332
42	192.2	44.063	0.0044	0.0382	-0.0339
43	192.2	44.83	0.0031	0.0377	-0.0346
44	192.2	45.823	0.0027	0.037	-0.0342
45	192.2	47.094	0.0023	0.0361	-0.0338
46	192.2	47.847	0.0025	0.0355	-0.0331
47	192.2	48.906	0.0022	0.0348	-0.0326
48	192.2	49.819	0.0019	0.0341	-0.0323
49	192.2	50.851	0.0018	0.0334	-0.0316
50	192.2	51.865	0.0018	0.0327	-0.0309
51	192.2	52.84	0.0016	0.032	-0.0304
52	192.2	53.809	0.0015	0.0313	-0.0298
53	192.2	54.865	0.0014	0.0306	-0.0292
54	192.2	55.865	0.0016	0.03	-0.0284
55	192.2	56.781	0.0016	0.0293	-0.0278
56	192.2	57.851	0.0016	0.0287	-0.0271
57	192.2	58.868	0.0016	0.028	-0.0264
58	192.2	59.837	0.0016	0.0274	-0.0258
59	192.2	60.819	0.0015	0.0268	-0.0253

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. E) Column 5 (2 pages) (Continued)

C0=1.0

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: inverse.in                                 *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.2632E+00	.480E+01	.183E+02
1	.2606E+00	.480E+01	.209E+02
2	.2589E+00	.477E+01	.227E+02
3	.2575E+00	.473E+01	.246E+02
4	.2564E+00	.470E+01	.265E+02
5	.2554E+00	.467E+01	.284E+02
6	.2546E+00	.464E+01	.303E+02
7	.2538E+00	.461E+01	.323E+02
8	.2531E+00	.458E+01	.343E+02
9	.2525E+00	.454E+01	.364E+02
10	.2520E+00	.451E+01	.386E+02
11	.2515E+00	.448E+01	.408E+02
12	.2510E+00	.444E+01	.429E+02
13	.2506E+00	.441E+01	.451E+02
14	.2503E+00	.438E+01	.472E+02
15	.2501E+00	.435E+01	.492E+02
16	.2499E+00	.433E+01	.510E+02
17	.2498E+00	.430E+01	.526E+02
18	.2497E+00	.428E+01	.540E+02
19	.2496E+00	.426E+01	.552E+02
20	.2496E+00	.425E+01	.562E+02
21	.2495E+00	.424E+01	.570E+02
22	.2495E+00	.423E+01	.577E+02
23	.2495E+00	.422E+01	.582E+02
24	.2495E+00	.422E+01	.586E+02
25	.2495E+00	.421E+01	.589E+02
26	.2495E+00	.421E+01	.592E+02
27	.2495E+00	.420E+01	.593E+02
28	.2495E+00	.420E+01	.595E+02
29	.2495E+00	.420E+01	.596E+02
30	.2495E+00	.420E+01	.597E+02
31	.2495E+00	.420E+01	.598E+02
32	.2495E+00	.420E+01	.598E+02
33	.2495E+00	.420E+01	.598E+02
34	.2495E+00	.420E+01	.599E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	.099	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .11377626
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .4228E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.4197E+01	.3151E+00	.1332E+02	.3566E+01	.4827E+01
D....	.5987E+02	.2281E+02	.2625E+01	.1423E+02	.1055E+03

------------------ORDERED BY COMPUTER INPUT------------------

$

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESIDUAL
1	194.2	0.8958	0.0019	0	0.0019
2	194.2	4.0208	0.0017	0	0.0017
3	194.2	10.8264	0.0037	0	0.0037
4	194.2	14.8715	0.0042	0.0006	0.0036
5	194.2	18.0069	0.0037	0.0034	0.0003
6	194.2	21.7778	0.0023	0.0125	-0.0103
7	194.2	24.7882	0.0024	0.0243	-0.0219
8	194.2	25.809	0.0024	0.0289	-0.0265
9	194.2	26.8021	0.0025	0.0334	-0.031

10	194.2	27.0868	0.0024	0.0347	-0.0323
11	194.2	27.8785	0.0028	0.0384	-0.0356
12	194.2	28.1528	0.0028	0.0397	-0.0369
13	194.2	28.75	0.0029	0.0424	-0.0395
14	194.2	29.1111	0.0027	0.044	-0.0414
15	194.2	29.7292	0.0031	0.0468	-0.0436
16	194.2	30.3229	0.0033	0.0493	-0.046
17	194.2	30.75	0.0036	0.0511	-0.0475
18	194.2	31.1389	0.0036	0.0527	-0.0491
19	194.2	31.7639	0.0034	0.0551	-0.0518
20	194.2	32.1007	0.0035	0.0564	-0.0529
21	194.2	32.75	0.0039	0.0587	-0.0548
22	194.2	33.0486	0.0041	0.0598	-0.0557
23	194.2	33.8264	0.0044	0.0623	-0.058
24	194.2	34.1493	0.0064	0.0633	-0.0569
25	194.2	34.7292	0.0168	0.0649	-0.0482
26	194.2	35.0833	0.0298	0.0659	-0.0361
27	194.2	35.6806	0.0606	0.0674	-0.0068
28	194.2	36.1285	0.0898	0.0684	0.0214
29	194.2	36.7917	0.1315	0.0697	0.0617
30	194.2	37.1285	0.1559	0.0704	0.0856
31	194.2	37.816	0.1889	0.0715	0.1174
32	194.2	38.125	0.1944	0.0719	0.1225
33	194.2	38.8785	0.2315	0.0728	0.1586
34	194.2	39.1458	0.2352	0.0731	0.1621
35	194.2	39.7882	0.2204	0.0737	0.1467
36	194.2	40.191	0.2056	0.0739	0.1316
37	194.2	40.8611	0.1276	0.0742	0.0534
38	194.2	41.1771	0.1144	0.0743	0.0401
39	194.2	41.8681	0.0787	0.0744	0.0043
40	194.2	42.2778	0.0578	0.0744	-0.0166
41	194.2	42.7917	0.0154	0.0743	-0.0588
42	194.2	44.059	0.0125	0.0737	-0.0612
43	194.2	44.8264	0.0065	0.0731	-0.0666
44	194.2	45.0868	0.0056	0.0729	-0.0672
45	194.2	45.8194	0.0039	0.0721	-0.0682
46	194.2	46.7882	0.0027	0.071	-0.0683
47	194.2	47.0903	0.0025	0.0706	-0.0681
48	194.2	47.8438	0.0024	0.0696	-0.0672
49	194.2	48.8993	0.0021	0.0679	-0.0659
50	194.2	49.816	0.0019	0.0664	-0.0645
51	194.2	50.8472	0.0018	0.0645	-0.0627
52	194.2	51.8611	0.0018	0.0626	-0.0608
53	194.2	52.8333	0.0016	0.0607	-0.0591
54	194.2	53.8021	0.0016	0.0587	-0.0571
55	194.2	54.8576	0.0014	0.0565	-0.0551
56	194.2	55.8611	0.0014	0.0544	-0.053
57	194.2	56.7778	0.0015	0.0525	-0.051
58	194.2	57.8438	0.0015	0.0503	-0.0488
59	194.2	58.8646	0.0016	0.0481	-0.0466
60	194.2	59.8333	0.0019	0.0461	-0.0443
61	194.2	60.8125	0.0015	0.0441	-0.0426

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. F) Column 6 (2 pages) (Continued)

```
C0=1.0

   *******************************************************************
   *                                                     *
   *  CXTFIT VERSION 2.1 (4/17/99)                         *
   *  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
   *  NON-LINEAR LEAST-SQUARES ANALYSIS                          *
   *                                                     *
   *  Comment                                              *
   *  Comment                                              *
   *                                                     *
   *  DATA INPUT FILE: inverse.in                          *
   *                                                     *
   *******************************************************************

   MODEL DESCRIPTION
   =================
     DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
     RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
     REAL TIME (t), POSITION(x)
      (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

   INITIAL VALUES OF COEFFICIENTS
   ==============================
   NAME      INITIAL VALUE  FITTING
    V........  .4800E+01     Y
    D........  .1830E+02     Y
    R........  .1000E+01     N
    mu.......  .0000E+00     N

   BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
   ============================================
    SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
    SOLUTE FREE INITIAL CONDITION
    NO PRODUCTION TERM

   PARAMETER ESTIMATION MODE
   =========================
    MAXIMUM NUMBER OF ITERATIONS =  50

   ITER   SSQ       V....    D....
    0  .6525E+00 .480E+01 .183E+02
    1  .4104E+00 .536E+01 .531E+02
    2  .3807E+00 .612E+01 .541E+02
    3  .3560E+00 .594E+01 .329E+02
    4  .3383E+00 .600E+01 .241E+02
    5  .3228E+00 .600E+01 .182E+02
    6  .3099E+00 .602E+01 .145E+02
    7  .3006E+00 .603E+01 .120E+02
    8  .2949E+00 .604E+01 .105E+02
    9  .2919E+00 .605E+01 .953E+01
   10  .2905E+00 .606E+01 .893E+01
   11  .2898E+00 .606E+01 .857E+01
   12  .2896E+00 .606E+01 .834E+01
   13  .2894E+00 .606E+01 .820E+01
   14  .2894E+00 .606E+01 .811E+01
   15  .2894E+00 .606E+01 .806E+01
   16  .2894E+00 .606E+01 .803E+01
   17  .2893E+00 .606E+01 .800E+01
   18  .2893E+00 .606E+01 .799E+01
   19  .2893E+00 .606E+01 .798E+01
   20  .2893E+00 .606E+01 .798E+01
   21  .2893E+00 .606E+01 .797E+01

   COVARIANCE MATRIX FOR FITTED PARAMETERS
   =======================================
          V....  D....
    V....  1.000
    D....  -.005  1.000

    RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .45857347
     (COEFFICIENT OF DETERMINATION)
```

MEAN SQUARE FOR ERROR (MSE) = .5076E-02

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

			95% CONFIDENCE LIMITS	
NAME VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V... .6063E+01	.6375E-01	.9511E+02	.5935E+01	.6191E+01
D... .7973E+01	.1240E+01	.6429E+01	.5490E+01	.1046E+02

-----------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	192.8	2.0625	0.0014	0	0.0014
2	192.8	4.0208	0.0014	0	0.0014
3	192.8	10.8333	0.0025	0	0.0025
4	192.8	14.875	0.003	0	0.003
5	192.8	18.0139	0.003	0	0.003
6	192.8	21.7847	0.0021	0.0005	0.0015
7	192.8	25.1215	0.002	0.0203	-0.0183
8	192.8	25.8194	0.002	0.0344	-0.0324
9	192.8	26.8125	0.0021	0.0648	-0.0627
10	192.8	27.0938	0.0022	0.0758	-0.0736
11	192.8	27.8889	0.0038	0.1122	-0.1084
12	192.8	28.1597	0.0073	0.1261	-0.1188
13	192.8	28.7604	0.0253	0.159	-0.1337
14	192.8	29.1181	0.0413	0.1793	-0.138
15	192.8	29.7361	0.0734	0.2142	-0.1409
16	192.8	30.3299	0.1216	0.2458	-0.1241
17	192.8	30.7604	0.1609	0.2662	-0.1053
18	192.8	31.1042	0.2011	0.2805	-0.0794
19	192.8	31.7743	0.2626	0.3021	-0.0396
20	192.8	32.1076	0.2942	0.3094	-0.0152
21	192.8	32.7535	0.3147	0.3164	-0.0016
22	192.8	33.0521	0.3222	0.3164	0.0058
23	192.8	33.8368	0.2942	0.3073	-0.0131
24	192.8	34.1563	0.2682	0.3002	-0.032
25	192.8	34.7361	0.2142	0.283	-0.0688
26	192.8	35.0903	0.1739	0.2702	-0.0962
27	192.8	35.684	0.1175	0.2459	-0.1284
28	192.8	36.1319	0.0823	0.2261	-0.1438
29	192.8	36.7986	0.046	0.1956	-0.1496
30	192.8	37.1354	0.0335	0.1802	-0.1466
31	192.8	37.8229	0.0188	0.1497	-0.1309
32	192.8	38.1319	0.0141	0.1368	-0.1226
33	192.8	38.8854	0.0097	0.1077	-0.098
34	192.8	39.1528	0.0077	0.0983	-0.0906
35	192.8	39.7986	0.0056	0.078	-0.0724
36	192.8	40.1979	0.0046	0.067	-0.0624
37	192.8	40.8681	0.0039	0.0512	-0.0472
38	192.8	41.184	0.0033	0.0448	-0.0415
39	192.8	41.875	0.0029	0.0331	-0.0302
40	192.8	42.2813	0.0026	0.0275	-0.0248
41	192.8	42.8264	0.0027	0.0212	-0.0185
42	192.8	44.0625	0.0022	0.0114	-0.0092
43	192.8	44.8264	0.0024	0.0076	-0.0052
44	192.8	45.8194	0.0023	0.0044	-0.0021
45	192.8	47.0938	0.0021	0.0021	0
46	192.8	47.8507	0.002	0.0013	0.0007
47	192.8	48.9063	0.0018	0.0007	0.0012
48	192.8	49.8229	0.0017	0.0004	0.0013
49	192.8	50.8542	0.0018	0.0002	0.0017
50	192.8	51.8646	0.0018	0.0001	0.0017
51	192.8	52.8403	0.0015	0	0.0014
52	192.8	53.809	0.0015	0	0.0014
53	192.8	54.8646	0.0014	0	0.0014
54	192.8	55.8646	0.0014	0	0.0014
55	192.8	56.7847	0.0015	0	0.0015
56	192.8	57.8507	0.0015	0	0.0015
57	192.8	58.8715	0.0016	0	0.0016
58	192.8	59.8368	0.0016	0	0.0016
59	192.8	60.8194	0.0014	0	0.0014

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. G) Column 7 (2 pages) (Continued)

C0=1.0

```
*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: inverse.in                                  *
*                                                               *
*****************************************************************
```

```
MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V.......   .4800E+01      Y
D.......   .1830E+02      Y
R.......   .1000E+01      N
mu......   .0000E+00      N


BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM


PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50


ITER   SSQ       V....    D....
0  .3445E+00 .480E+01 .183E+02
1  .2090E+00 .466E+01 .408E+02
2  .1283E+00 .430E+01 .880E+02
3  .8743E-01 .373E+01 .180E+03
4  .7607E-01 .317E+01 .300E+03
5  .7451E-01 .287E+01 .386E+03
6  .7443E-01 .277E+01 .402E+03
7  .7443E-01 .276E+01 .405E+03
8  .7443E-01 .276E+01 .405E+03
9  .7443E-01 .276E+01 .405E+03


COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
       V....  D....
 V.... 1.000
 D....  .709  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .04611520
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .1329E-02


NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================
```

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.2758E+01	.7981E+00	.3456E+01	.1159E+01	.4357E+01
D....	.4051E+03	.3996E+03	.1014E+01	-.3954E+03	.1206E+04

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	CONCENTRATION FITTED	RESI-DUAL
1	191.2	2.0625	0.0016	0	0.0016
2	191.2	4.0208	0.0017	0.0001	0.0015
3	191.2	10.8299	0.0094	0.0111	-0.0017
4	191.2	14.8715	0.0041	0.0181	-0.014
5	191.2	18.0069	0.0043	0.0216	-0.0173
6	191.2	21.7813	0.0023	0.0239	-0.0216
7	191.2	24.7917	0.0021	0.0248	-0.0227
8	191.2	25.809	0.0022	0.025	-0.0228
9	191.2	26.8056	0.0023	0.0251	-0.0228
10	191.2	27.0903	0.0024	0.0251	-0.0227
11	191.2	27.8819	0.0028	0.0252	-0.0223
12	191.2	28.1528	0.0028	0.0252	-0.0223
13	191.2	28.7535	0.0032	0.0252	-0.022
14	191.2	29.1111	0.0032	0.0252	-0.022
15	191.2	29.7326	0.0035	0.0252	-0.0216
16	191.2	30.3264	0.0038	0.0251	-0.0214
17	191.2	30.7535	0.0047	0.0251	-0.0204
18	191.2	31.0972	0.0075	0.0251	-0.0176
19	191.2	31.7674	0.0224	0.025	-0.0026
20	191.2	32.1042	0.0402	0.025	0.0152
21	191.2	32.75	0.077	0.0249	0.0521
22	191.2	33.0486	0.0961	0.0249	0.0712
23	191.2	33.8264	0.1252	0.0248	0.1004
24	191.2	34.1528	0.1333	0.0248	0.1085
25	191.2	34.7292	0.129	0.0247	0.1043
26	191.2	35.0833	0.1213	0.0246	0.0967
27	191.2	35.6806	0.0979	0.0245	0.0734
28	191.2	36.1285	0.0753	0.0245	0.0509
29	191.2	36.7917	0.0439	0.0244	0.0196
30	191.2	37.1285	0.0351	0.0243	0.0108
31	191.2	37.816	0.0219	0.0242	-0.0023
32	191.2	38.1285	0.018	0.0241	-0.0061
33	191.2	39.1458	0.0111	0.0239	-0.0128
34	191.2	39.7917	0.0085	0.0238	-0.0153
35	191.2	40.191	0.0073	0.0237	-0.0164
36	191.2	40.8646	0.0047	0.0236	-0.0189
37	191.2	41.1771	0.0046	0.0235	-0.0189
38	191.2	41.8681	0.0039	0.0233	-0.0194
39	191.2	42.2778	0.0034	0.0233	-0.0198
40	191.2	42.8194	0.0027	0.0231	-0.0204
41	191.2	44.059	0.0022	0.0229	-0.0207
42	191.2	44.8264	0.0024	0.0227	-0.0203
43	191.2	45.8194	0.0023	0.0224	-0.0202
44	191.2	47.0903	0.0021	0.0222	-0.02
45	191.2	47.8438	0.0021	0.022	-0.0199
46	191.2	48.9028	0.0019	0.0217	-0.0198
47	191.2	49.816	0.0018	0.0215	-0.0197
48	191.2	50.8472	0.0017	0.0213	-0.0195
49	191.2	51.8611	0.0016	0.021	-0.0194
50	191.2	52.8368	0.0016	0.0208	-0.0192
51	191.2	53.8056	0.0016	0.0206	-0.019
52	191.2	54.8611	0.0015	0.0203	-0.0188
53	191.2	55.8611	0.0015	0.0201	-0.0186
54	191.2	56.7813	0.0016	0.0199	-0.0183
55	191.2	57.8438	0.0015	0.0196	-0.0181
56	191.2	58.8646	0.0016	0.0194	-0.0178
57	191.2	59.8333	0.0015	0.0192	-0.0176
58	191.2	60.816	0.0015	0.0189	-0.0174

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. H) Column 8 (2 pages) (Continued)

```
C0=1.0

 *****************************************************************
 *                                                          *
 *   CXTFIT VERSION 2.1 (4/17/99)                             *
 *   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                      *
 *   NON-LINEAR LEAST-SQUARES ANALYSIS                              *
 *                                                          *
 *   Comment                                                  *
 *   Comment                                                  *
 *                                                          *
 *   DATA INPUT FILE:  inverse.in                               *
 *                                                          *
 *****************************************************************

 MODEL DESCRIPTION
 =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME       INITIAL VALUE  FITTING
 V........   .4800E+01     Y
 D........   .1830E+02     Y
 R........   .1000E+01     N
 mu.......   .0000E+00     N

 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
  SINGLE PULSE OF CONC. =   1.0000 & DURATION =   3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

 PARAMETER ESTIMATION MODE
 =========================
  MAXIMUM NUMBER OF ITERATIONS =  50

 ITER   SSQ       V...      D...
 0   .1086E+01  .480E+01  .183E+02
 1   .6983E+00  .534E+01  .653E+02
 2   .6356E+00  .726E+01  .993E+02
 3   .3465E+00  .646E+01  .483E+01
 4   .3454E+00  .644E+01  .476E+01
 5   .3453E+00  .644E+01  .471E+01
 6   .3453E+00  .644E+01  .469E+01
 7   .3453E+00  .644E+01  .467E+01
 8   .3453E+00  .644E+01  .466E+01
 9   .3453E+00  .644E+01  .466E+01
 10   .3453E+00  .644E+01  .466E+01
 11   .3453E+00  .644E+01  .466E+01

 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
        V...   D...
  V....  1.000
  D....  -.006  1.000

  RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .58128195
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .6166E-02

 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
 ================================================
```

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6441E+01	.4885E-01	.1318E+03	.6344E+01	.6539E+01
D....	.4655E+01	.7112E+00	.6546E+01	.3231E+01	.6080E+01

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	190.4	4.0208	0.0017	0	0.0017
2	190.4	10.8299	0.0048	0	0.0048
3	190.4	14.8715	0.005	0	0.005
4	190.4	18.0104	0.0039	0	0.0039
5	190.4	21.7813	0.0027	0.0002	0.0024
6	190.4	24.7917	0.0023	0.0212	-0.0189
7	190.4	25.816	0.0026	0.0582	-0.0556
8	190.4	26.8056	0.0078	0.124	-0.1162
9	190.4	27.0903	0.0139	0.1486	-0.1347
10	190.4	27.8854	0.0295	0.2275	-0.198
11	190.4	28.1563	0.0544	0.2563	-0.2019
12	190.4	28.7535	0.1432	0.3189	-0.1757
13	190.4	29.1146	0.2289	0.3538	-0.1249
14	190.4	29.7326	0.3315	0.403	-0.0715
15	190.4	30.3264	0.4176	0.4327	-0.0151
16	190.4	30.7569	0.4359	0.4414	-0.0055
17	190.4	31.1007	0.4176	0.4403	-0.0227
18	190.4	31.7674	0.3516	0.4189	-0.0673
19	190.4	32.1042	0.304	0.3997	-0.0957
20	190.4	32.75	0.2125	0.3514	-0.1389
21	190.4	33.0486	0.1659	0.3255	-0.1596
22	190.4	33.8299	0.078	0.254	-0.176
23	190.4	34.1528	0.0522	0.2248	-0.1726
24	190.4	34.7326	0.0286	0.1756	-0.147
25	190.4	35.0868	0.0185	0.1485	-0.13
26	190.4	35.6806	0.0106	0.109	-0.0984
27	190.4	36.1319	0.0129	0.0843	-0.0714
28	190.4	36.7951	0.0053	0.0558	-0.0505
29	190.4	37.1319	0.0042	0.0446	-0.0404
30	190.4	37.816	0.0033	0.0275	-0.0242
31	190.4	38.1285	0.0031	0.0218	-0.0187
32	190.4	38.8819	0.0034	0.012	-0.0086
33	190.4	39.1458	0.003	0.0097	-0.0066
34	190.4	39.7917	0.0028	0.0055	-0.0028
35	190.4	40.1944	0.0027	0.0039	-0.0012
36	190.4	40.8646	0.0028	0.0021	0.0007
37	190.4	41.1771	0.0025	0.0015	0.001
38	190.4	41.8681	0.0024	0.0008	0.0016
39	190.4	42.2778	0.0023	0.0005	0.0018
40	190.4	42.8194	0.0022	0.0003	0.002
41	190.4	44.059	0.0021	0.0001	0.002
42	190.4	44.8299	0.0021	0	0.0021
43	190.4	45.8229	0.002	0	0.002
44	190.4	47.0938	0.002	0	0.002
45	190.4	47.8472	0.0019	0	0.0019
46	190.4	48.9028	0.0018	0	0.0018
47	190.4	49.8194	0.0018	0	0.0018
48	190.4	50.8507	0.0016	0	0.0016
49	190.4	51.8611	0.0015	0	0.0015
50	190.4	52.8368	0.0015	0	0.0015
51	190.4	53.8056	0.0015	0	0.0015
52	190.4	54.8611	0.0014	0	0.0014
53	190.4	55.8646	0.0014	0	0.0014
54	190.4	56.7813	0.0015	0	0.0015
55	190.4	57.8472	0.0015	0	0.0015
56	190.4	58.8681	0.0015	0	0.0015
57	190.4	59.8368	0.0014	0	0.0014
58	190.4	60.816	0.0014	0	0.0014

Table A-11. Test 1 Unmodified Outlet CXTFIT Data. I) Column 9 (2 pages) (Continued)

```
C0=1 0

 ******************************************************************
 *                                                                *
 *   CXTFIT VERSION 2.1 (4/17/99)                                 *
 *   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
 *   NON-LINEAR LEAST-SQUARES ANALYSIS                            *
 *                                                                *
 *   Comment                                                      *
 *   Comment                                                      *
 *                                                                *
 *   DATA INPUT FILE:  inverse.in                                 *
 *                                                                *
 ******************************************************************


 MODEL DESCRIPTION
 =================
   DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
   RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
   REAL TIME (t), POSITION(x)
    (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


 INITIAL VALUES OF COEFFICIENTS
 ==============================
 NAME      INITIAL VALUE   FITTING
 V.......   .4800E+01     Y
 D.......   .1830E+02     Y
 R.......   .1000E+01     N
 mu......   .0000E+00     N


 BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
 ============================================
  SINGLE PULSE OF CONC. =    1.0000 & DURATION =   3.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM


 PARAMETER ESTIMATION MODE
 =========================
  MAXIMUM NUMBER OF ITERATIONS =  50


 ITER    SSQ        V....      D....
  0   .8921E+00  .480E+01  .183E+02
  1   .4417E+00  .564E+01  .639E+02
  2   .4062E+00  .779E+01  .372E+02
  3   .3577E+00  .600E+01  .516E+02
  4   .2071E+00  .663E+01  .313E+02
  5   .1244E+00  .642E+01  .488E+01
  6   .7025E-01  .640E+01  .701E+01
  7   .6325E-01  .641E+01  .814E+01
  8   .6254E-01  .641E+01  .857E+01
  9   .6248E-01  .641E+01  .870E+01
 10   .6247E-01  .641E+01  .874E+01
 11   .6247E-01  .641E+01  .875E+01


 COVARIANCE MATRIX FOR FITTED PARAMETERS
 =======================================
         V....  D....
   V....  1.000
   D....   .092  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .90866064
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .1096E-02


 NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
```

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6413E+01	.3340E-01	.1920E+03	.6346E+01	.6480E+01
D....	.8748E+01	.6463E+00	.1353E+02	.7453E+01	.1004E+02

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESIDUAL
1	187.9	0.8958	0.0016	0	0.0016
2	187.9	4.0208	0.0016	0	0.0016
3	187.9	10.8368	0.0032	0	0.0032
4	187.9	14.8819	0.0036	0	0.0036
5	187.9	18.0139	0.003	0	0.003
6	187.9	21.7951	0.0026	0.0066	-0.0039
7	187.9	25.125	0.0296	0.0905	-0.0609
8	187.9	25.8194	0.0566	0.1274	-0.0708
9	187.9	26.816	0.1169	0.1882	-0.0713
10	187.9	27.0972	0.1353	0.2059	-0.0706
11	187.9	27.8924	0.2004	0.2537	-0.0534
12	187.9	28.1632	0.2224	0.2685	-0.0461
13	187.9	28.7604	0.2445	0.2968	-0.0523
14	187.9	29.1215	0.2721	0.3103	-0.0383
15	187.9	29.7396	0.2941	0.3262	-0.0321
16	187.9	30.3333	0.3033	0.3322	-0.0289
17	187.9	30.7639	0.3143	0.3308	-0.0165
18	187.9	31.1042	0.3143	0.3264	-0.0121
19	187.9	31.7743	0.3033	0.3103	-0.007
20	187.9	32.1111	0.2813	0.2989	-0.0176
21	187.9	32.7569	0.2555	0.2724	-0.0169
22	187.9	33.0556	0.2335	0.2587	-0.0252
23	187.9	33.8368	0.1768	0.2201	-0.0433
24	187.9	34.1597	0.1515	0.2038	-0.0523
25	187.9	34.7396	0.1175	0.1749	-0.0574
26	187.9	35.0938	0.0967	0.1579	-0.0612
27	187.9	35.6875	0.0691	0.1311	-0.062
28	187.9	36.1354	0.0518	0.1126	-0.0608
29	187.9	36.8021	0.0303	0.0883	-0.0579
30	187.9	37.1354	0.0246	0.0776	-0.0529
31	187.9	37.8229	0.0153	0.0585	-0.0432
32	187.9	38.1354	0.0126	0.0511	-0.0385
33	187.9	38.8889	0.0081	0.0363	-0.0283
34	187.9	39.1528	0.0073	0.0321	-0.0248
35	187.9	39.8021	0.0055	0.0233	-0.0178
36	187.9	40.2014	0.0047	0.0191	-0.0144
37	187.9	40.8715	0.0032	0.0134	-0.0102
38	187.9	41.184	0.003	0.0113	-0.0083
39	187.9	41.875	0.0028	0.0077	-0.0049
40	187.9	42.2847	0.0027	0.0061	-0.0034
41	187.9	42.8264	0.0022	0.0044	-0.0022
42	187.9	44.0625	0.002	0.0021	-0.0001
43	187.9	44.8333	0.0021	0.0013	0.0008
44	187.9	45.8264	0.0021	0.0007	0.0014
45	187.9	47.0972	0.002	0.0003	0.0017
46	187.9	47.8507	0.0019	0.0002	0.0018
47	187.9	48.9063	0.0019	0.0001	0.0018
48	187.9	49.8229	0.0017	0	0.0017
49	187.9	50.8542	0.0017	0	0.0017
50	187.9	51.8646	0.0018	0	0.0018
51	187.9	52.8403	0.0015	0	0.0015
52	187.9	53.809	0.0015	0	0.0015
53	187.9	54.8646	0.0014	0	0.0014
54	187.9	55.8681	0.0014	0	0.0014
55	187.9	56.7847	0.0015	0	0.0015
56	187.9	57.8507	0.0017	0	0.0017
57	187.9	58.8715	0.0016	0	0.0016
58	187.9	59.8403	0.0015	0	0.0015
59	187.9	60.8194	0.0014	0	0.0014

Table A-12. Test 1 Modified Outlet CXTFIT Data. A) Column 1 (2 pages)

C0 Modified

```
*******************************************************************
*                                                                 *
*   CXTFIT VERSION 2.1 (4/17/99)                                  *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                             *
*                                                                 *
*   Comment                                                       *
*   Comment                                                       *
*                                                                 *
*   DATA INPUT FILE: inverse in                                   *
*                                                                 *
*******************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE   FITTING
V........  .4800E+01       Y
D........  .1830E+02       Y
R........  .1000E+01       N
mu.......  .0000E+00       N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =  .3400 & DURATION =  3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ        V.....     D.....
0   .1516E+00  .480E+01  .183E+02
1   .1427E+00  .628E+01  .205E+02
2   .8758E-01  .548E+01  .134E+02
3   .4350E-01  .565E+01  .668E+01
4   .1030E-01  .564E+01  .334E+01
5   .2230E-02  .563E+01  .151E+01
6   .3742E-03  .563E+01  .187E+01
7   .3532E-03  .563E+01  .191E+01
8   .3532E-03  .563E+01  .191E+01
9   .3532E-03  .563E+01  .191E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....   D....
 V....  1.000
 D....  -.062   1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99811415
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .6196E-05

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================
```

NAME	VALUE	S.E.COEFF.	T-VALUE	95% CONFIDENCE LIMITS LOWER	UPPER
V....	.5634E+01	.2508E-02	.2246E+04	.5629E+01	.5639E+01
D....	.1914E+01	.2595E-01	.7378E+02	.1862E+01	.1966E+01

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	193.6	0.8958	0.0033	0	0.0033
2	193.6	4.0208	0.0019	0	0.0019
3	193.6	10.8264	0.0024	0	0.0024
4	193.6	14.8715	0.0024	0	0.0024
5	193.6	18.0069	0.0031	0	0.0031
6	193.6	21.7778	0.0019	0	0.0019
7	193.6	24.7569	0.002	0	0.002
8	193.6	25.7882	0.0018	0	0.0018
9	193.6	26.8021	0.0022	0	0.0022
10	193.6	27.0868	0.0022	0	0.0022
11	193.6	27.8785	0.0023	0.0001	0.0022
12	193.6	28.1528	0.0027	0.0001	0.0026
13	193.6	28.75	0.0029	0.0004	0.0024
14	193.6	29.1076	0.0037	0.0008	0.0029
15	193.6	29.7292	0.0057	0.0024	0.0033
16	193.6	30.3229	0.0092	0.0058	0.0034
17	193.6	30.75	0.0123	0.0102	0.0021
18	193.6	31.0972	0.0163	0.0154	0.0009
19	193.6	31.7639	0.0289	0.0308	-0.0019
20	193.6	32.1007	0.041	0.0416	-0.0006
21	193.6	32.7465	0.068	0.0681	-0.0001
22	193.6	33.0451	0.0833	0.0825	0.0008
23	193.6	33.8264	0.1207	0.123	-0.0023
24	193.6	34.1493	0.136	0.1392	-0.0032
25	193.6	34.7292	0.1628	0.1639	-0.0011
26	193.6	35.0833	0.1743	0.1747	-0.0004
27	193.6	35.6771	0.1839	0.1833	0.0006
28	193.6	36.1285	0.1818	0.1813	0.0005
29	193.6	36.7917	0.1638	0.1657	-0.0019
30	193.6	37.1285	0.1508	0.1532	-0.0025
31	193.6	37.8125	0.1232	0.1225	0.0007
32	193.6	38.125	0.1057	0.1075	-0.0017
33	193.6	38.8785	0.0791	0.073	0.0061
34	193.6	39.1424	0.0642	0.0623	0.0019
35	193.6	39.7882	0.0354	0.0401	-0.0047
36	193.6	40.191	0.0241	0.0295	-0.0054
37	193.6	40.8611	0.0111	0.0167	-0.0056
38	193.6	41.1736	0.0082	0.0125	-0.0043
39	193.6	41.8646	0.0052	0.0062	-0.0011
40	193.6	42.2778	0.004	0.004	0
41	193.6	42.8194	0.003	0.0021	0.0009
42	193.6	44.0556	0.0022	0.0004	0.0018
43	193.6	44.8264	0.0025	0.0001	0.0024
44	193.6	45.8194	0.0021	0	0.0021
45	193.6	47.0903	0.0025	0	0.0025
46	193.6	47.8438	0.0021	0	0.0021
47	193.6	48.8993	0.0024	0	0.0024
48	193.6	49.816	0.0022	0	0.0022
49	193.6	50.8472	0.0018	0	0.0018
50	193.6	51.8576	0.0018	0	0.0018
51	193.6	52.8333	0.0018	0	0.0018
52	193.6	53.8021	0.0015	0	0.0015
53	193.6	54.8576	0.0016	0	0.0016
54	193.6	55.8576	0.0014	0	0.0014
55	193.6	56.7778	0.0017	0	0.0017
56	193.6	57.8438	0.0017	0	0.0017
57	193.6	58.8646	0.0017	0	0.0017
58	193.6	59.8333	0.0017	0	0.0017
59	193.6	60.8125	0.0015	0	0.0015

(Table continued on next page)

Table A-12. Test 1 Modified Outlet CXTFIT Data. B) Column 2 (2 pages) (Continued)

C0 Modified

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: inverse.in                                 *
*                                                               *
*****************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V.......   .4800E+01      Y
D.......   .1830E+02      Y
R.......   1000E+01       N
mu......   .0000E+00      N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =    .2100 & DURATION =    3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ        V...     D...
0   .5517E-01  .480E+01  .183E+02
1   .4814E-01  .344E+01  .288E+02
2   .3634E-01  .423E+01  .144E+02
3   .2387E-01  .405E+01  .719E+01
4   .1201E-01  .411E+01  .359E+01
5   .3600E-02  .410E+01  .180E+01
6   .2287E-02  .411E+01  .116E+01
7   .2192E-02  .412E+01  .123E+01
8   .2192E-02  .412E+01  .123E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
      V...   D...
 V...  1.000
 D...  -.133  1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .95891379
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .3425E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                           95% CONFIDENCE LIMITS
NAME   VALUE    S.E.COEFF.  T-VALUE   LOWER      UPPER
V....  .4115E+01  .8222E-02  5005E+03  .4099E+01  .4132E+01
D....  .1229E+01  .6991E-01  1758E+02  .1089E+01  .1369E+01
```

-----------------ORDERED BY COMPUTER INPUT------------------

S NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	192.1	4.0208	0.0017	0	0.0017
2	192.1	10.8333	0.0075	0	0.0075
3	192.1	14.8819	0.0024	0	0.0024
4	192.1	18.0139	0.0031	0	0.0031
5	192.1	21.7778	0.0019	0	0.0019
6	192.1	25.125	0.0017	0	0.0017
7	192.1	25.8264	0.0018	0	0.0018
8	192.1	26.8125	0.0021	0	0.0021
9	192.1	27.0972	0.0022	0	0.0022
10	192.1	27.8889	0.0023	0	0.0023
11	192.1	28.1597	0.0023	0	0.0023
12	192.1	28.7604	0.0023	0	0.0023
13	192.1	29.1181	0.0023	0	0.0023
14	192.1	29.7396	0.0026	0	0.0026
15	192.1	30.3333	0.0027	0	0.0027
16	192.1	30.7639	0.0025	0	0.0025
17	192.1	31.1042	0.0025	0	0.0025
18	192.1	31.7743	0.0025	0	0.0025
19	192.1	32.1111	0.0026	0	0.0026
20	192.1	32.7569	0.0028	0	0.0028
21	192.1	33.0556	0.003	0	0.003
22	192.1	33.8333	0.0033	0	0.0033
23	192.1	34.1597	0.0034	0	0.0034
24	192.1	34.7361	0.002	0	0.002
25	192.1	35.0903	0.002	0	0.002
26	192.1	35.6875	0.0023	0	0.0023
27	192.1	36.1354	0.0019	0	0.0019
28	192.1	36.7986	0.0023	0	0.0023
29	192.1	37.1354	0.0022	0	0.0022
30	192.1	37.8229	0.0021	0	0.0021
31	192.1	38.1354	0.0022	0	0.0022
32	192.1	38.8889	0.0022	0.0001	0.0021
33	192.1	39.1528	0.002	0.0002	0.0018
34	192.1	39.7986	0.0019	0.0004	0.0015
35	192.1	40.1979	0.002	0.0008	0.0012
36	192.1	40.8681	0.0023	0.0018	0.0005
37	192.1	41.184	0.0022	0.0025	-0.0003
38	192.1	41.875	0.0025	0.0053	-0.0028
39	192.1	42.2847	0.0032	0.0078	-0.0046
40	192.1	42.8264	0.0046	0.0123	-0.0077
41	192.1	44.0625	0.0171	0.0293	-0.0122
42	192.1	44.8333	0.0352	0.0441	-0.0089
43	192.1	45.0868	0.0448	0.0494	-0.0046
44	192.1	45.8264	0.068	0.0649	0.0031
45	192.1	46.7917	0.0933	0.0822	0.0111
46	192.1	47.0972	0.101	0.0861	0.0149
47	192.1	47.8507	0.105	0.0914	0.0136
48	192.1	48.1806	0.0912	0.0916	-0.0004
49	192.1	48.9063	0.0829	0.0875	-0.0046
50	192.1	49.1771	0.073	0.0845	-0.0115
51	192.1	49.8229	0.0634	0.075	-0.0116
52	192.1	50.0521	0.056	0.071	-0.015
53	192.1	50.8542	0.0509	0.0558	-0.0049
54	192.1	51.8646	0.0455	0.0371	0.0084
55	192.1	52.8403	0.033	0.0224	0.0106
56	192.1	53.0938	0.0301	0.0194	0.0107
57	192.1	53.809	0.0244	0.0123	0.0121
58	192.1	54.8646	0.0121	0.0058	0.0063
59	192.1	55.1563	0.0101	0.0046	0.0055
60	192.1	55.8646	0.0054	0.0025	0.0029
61	192.1	56.0903	0.004	0.0021	0.0019
62	192.1	56.7847	0.0026	0.0011	0.0015
63	192.1	57.8507	0.0017	0.0004	0.0013
64	192.1	58.8715	0.0016	0.0001	0.0015
65	192.1	59.8403	0.0017	0	0.0017
66	192.1	60.8194	0.0015	0	0.0015

Table A-12. Test 1 Modified Outlet CXTFIT Data. C) Column 3 (2 pages) (Continued)

C0 Modified

```
*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: inverse.in                                  *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION
=================

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
==

SINGLE PULSE OF CONC. = .3300 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.2681E+00	.480E+01	.183E+02
1	.2339E+00	.653E+01	.542E+02
2	.2227E+00	.529E+01	.271E+02
3	.1539E+00	.613E+01	.136E+02
4	.9986E-01	.592E+01	.678E+01
5	.4469E-01	.600E+01	.339E+01
6	.8997E-02	.600E+01	.169E+01
7	.1041E-02	.600E+01	.849E+00
8	.3936E-03	.600E+01	.978E+00
9	.3884E-03	.600E+01	.991E+00
10	.3884E-03	.600E+01	.991E+00

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================

	V....	D....
V....	1.000	
D....	-.135	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99856985
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .6936E-05

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
==

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6002E+01	.1913E-02	.3138E+04	.5998E+01	.6006E+01
D....	.9909E+00	.1556E-01	.6368E+02	.9597E+00	.1022E+01

-----------------ORDERED BY COMPUTER INPUT-----------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	193.5	4.0208	0.0014	0	0.0014
2	193.5	10.8299	0.0022	0	0.0022
3	193.5	14.8889	0.002	0	0.002
4	193.5	18.0104	0.0022	0	0.0022
5	193.5	21.7813	0.0013	0	0.0013
6	193.5	24.7917	0.0012	0	0.0012
7	193.5	25.8125	0.0013	0	0.0013
8	193.5	26.8056	0.0016	0	0.0016
9	193.5	27.0903	0.0016	0	0.0016
10	193.5	27.8854	0.0021	0.0001	0.002
11	193.5	28.1563	0.0025	0.0002	0.0023
12	193.5	28.7535	0.004	0.0009	0.0031
13	193.5	29.1146	0.0062	0.0022	0.004
14	193.5	29.7326	0.0114	0.0082	0.0032
15	193.5	30.3264	0.0251	0.0228	0.0023
16	193.5	30.7535	0.039	0.0417	-0.0027
17	193.5	31.1007	0.0601	0.0632	-0.0031
18	193.5	31.7674	0.116	0.118	-0.002
19	193.5	32.1042	0.1483	0.1495	-0.0012
20	193.5	32.75	0.2091	0.2054	0.0037
21	193.5	33.0486	0.2281	0.225	0.0032
22	193.5	33.8299	0.2452	0.2438	0.0014
23	193.5	34.1528	0.2338	0.2361	-0.0023
24	193.5	34.7326	0.2015	0.2026	-0.001
25	193.5	35.0868	0.1738	0.1734	0.0003
26	193.5	35.6806	0.1179	0.1201	-0.0022
27	193.5	36.1319	0.0827	0.0829	-0.0002
28	193.5	36.7951	0.0416	0.0416	0
29	193.5	37.1319	0.0302	0.0275	0.0028
30	193.5	37.8194	0.0163	0.0102	0.0061
31	193.5	38.1285	0.0118	0.0062	0.0056
32	193.5	38.8819	0.0063	0.0016	0.0047
33	193.5	39.1458	0.0057	0.0009	0.0048
34	193.5	39.7917	0.0042	0.0002	0.004
35	193.5	40.1944	0.0036	0.0001	0.0035
36	193.5	40.8646	0.003	0	0.003
37	193.5	41.1806	0.0027	0	0.0027
38	193.5	41.8715	0.0025	0	0.0025
39	193.5	42.2813	0.0024	0	0.0024
40	193.5	42.8229	0.0024	0	0.0024
41	193.5	44.066	0.0021	0	0.0021
42	193.5	44.8333	0.0029	0	0.0029
43	193.5	45.8264	0.0023	0	0.0023
44	193.5	47.0972	0.0025	0	0.0025
45	193.5	47.8507	0.0022	0	0.0022
46	193.5	48.9063	0.0025	0	0.0025
47	193.5	49.8229	0.0021	0	0.0021
48	193.5	50.8542	0.0019	0	0.0019
49	193.5	51.8681	0.0018	0	0.0018
50	193.5	52.8403	0.0017	0	0.0017
51	193.5	53.809	0.0016	0	0.0016
52	193.5	54.8646	0.0017	0	0.0017
53	193.5	55.8681	0.0015	0	0.0015
54	193.5	56.7847	0.0017	0	0.0017
55	193.5	57.8507	0.0016	0	0.0016
56	193.5	58.8715	0.0017	0	0.0017
57	193.5	59.8403	0.0016	0	0.0016
58	193.5	60.8194	0.0015	0	0.0015

Table A-12. Test 1 Modified Outlet CXTFIT Data. D) Column 4 (2 pages) (Continued)

C0 Modified

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE:  inverse.in                                *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu........	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = .2800 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.1073E+00	.480E+01	.183E+02
1	.8460E-01	.641E+01	.432E+02
2	.7195E-01	.537E+01	.216E+02
3	.3231E-01	.596E+01	.108E+02
4	.1048E-01	.592E+01	.540E+01
5	.3767E-02	.595E+01	.209E+01
6	.1983E-02	.596E+01	.263E+01
7	.1914E-02	.596E+01	.277E+01
8	.1912E-02	.596E+01	.279E+01
9	.1912E-02	.596E+01	.279E+01
10	.1912E-02	.596E+01	.279E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.071	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .98328658
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .3355E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V...	.5958E+01	.9011E-02	.6612E+03	.5940E+01	.5976E+01
D....	.2789E+01	1078E+00	.2588E+02	.2573E+01	.3004E+01

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	192.2	0.896	0.0018	0	0.0018
2	192.2	4.021	0.0015	0	0.0015
3	192.2	10.83	0.0026	0	0.0026
4	192.2	14.875	0.0033	0	0.0033
5	192.2	18.01	0.003	0	0.003
6	192.2	21.785	0.0022	0	0.0022
7	192.2	25.122	0.0022	0	0.0022
8	192.2	25.823	0.0022	0.0002	0.0021
9	192.2	26.809	0.0025	0.0011	0.0014
10	192.2	27.094	0.003	0.0017	0.0012
11	192.2	27.889	0.0051	0.0051	0
12	192.2	28.16	0.0062	0.0071	-0.0009
13	192.2	28.757	0.0123	0.0137	-0.0014
14	192.2	29.118	0.0179	0.0195	-0.0015
15	192.2	29.736	0.028	0.033	-0.005
16	192.2	30.33	0.047	0.0503	-0.0032
17	192.2	30.76	0.0596	0.0649	-0.0053
18	192.2	31.104	0.0768	0.0775	-0.0007
19	192.2	31.771	0.107	0.1017	0.0053
20	192.2	32.108	0.1208	0.1129	0.0079
21	192.2	32.753	0.1345	0.1298	0.0047
22	192.2	33.052	0.1419	0.1349	0.007
23	192.2	33.833	0.1425	0.1385	0.004
24	192.2	34.156	0.1383	0.1358	0.0025
25	192.2	34.736	0.1255	0.1256	0
26	192.2	35.09	0.1149	0.1166	-0.0017
27	192.2	35.684	0.0928	0.0985	-0.0057
28	192.2	36.132	0.0779	0.0837	-0.0058
29	192.2	36.799	0.0571	0.0622	-0.0051
30	192.2	37.132	0.0478	0.0524	-0.0046
31	192.2	37.819	0.039	0.0351	0.004
32	192.2	38.132	0.0364	0.0286	0.0078
33	192.2	38.885	0.0286	0.0167	0.0119
34	192.2	39.149	0.0257	0.0135	0.0122
35	192.2	39.795	0.0259	0.0079	0.018
36	192.2	40.198	0.0234	0.0055	0.0179
37	192.2	40.868	0.0137	0.0029	0.0108
38	192.2	41.184	0.0124	0.0021	0.0103
39	192.2	41.872	0.01	0.001	0.009
40	192.2	42.281	0.0087	0.0006	0.008
41	192.2	42.826	0.0059	0.0003	0.0055
42	192.2	44.063	0.0044	0.0001	0.0043
43	192.2	44.83	0.0031	0	0.0031
44	192.2	45.823	0.0027	0	0.0027
45	192.2	47.094	0.0023	0	0.0023
46	192.2	47.847	0.0025	0	0.0025
47	192.2	48.906	0.0022	0	0.0022
48	192.2	49.819	0.0019	0	0.0019
49	192.2	50.851	0.0018	0	0.0018
50	192.2	51.865	0.0018	0	0.0018
51	192.2	52.84	0.0016	0	0.0016
52	192.2	53.809	0.0015	0	0.0015
53	192.2	54.865	0.0014	0	0.0014
54	192.2	55.865	0.0016	0	0.0016
55	192.2	56.781	0.0016	0	0.0016
56	192.2	57.851	0.0016	0	0.0016
57	192.2	58.868	0.0016	0	0.0016
58	192.2	59.837	0.0016	0	0.0016
59	192.2	60.819	0.0015	0	0.0015

Table A-12. Test 1 Modified Outlet CXTFIT Data. E) Column 5 (2 pages) (Continued)

C0 Modified

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*******************************************************************
*                                                    *
*   CXTFIT VERSION 2.1 (4/17/99)                     *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE     *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                *
*                                                    *
*   Comment                                          *
*   Comment                                          *
*                                                    *
*   DATA INPUT FILE:  inverse.in                     *
*                                                    *
*******************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = .3800 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.2006E+00	.480E+01	.183E+02
1	.1339E+00	.524E+01	.915E+01
2	.7326E-01	.516E+01	.458E+01
3	.2369E-01	.518E+01	.229E+01
4	.1317E-01	.519E+01	.644E+00
5	.2426E-02	.519E+01	.991E+00
6	.2075E-02	.519E+01	.108E+01
7	.2074E-02	.519E+01	.109E+01
8	.2074E-02	.519E+01	.109E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.123	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99263307
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .3515E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

NAME	VALUE	S.E.COEFF.	T-VALUE	95% CONFIDENCE LIMITS LOWER	UPPER
V....	.5186E+01	.3813E-02	.1360E+04	.5178E+01	.5193E+01
D....	.1087E+01	.3197E-01	.3400E+02	.1023E+01	.1151E+01

-----------------ORDERED BY COMPUTER INPUT------------------

CONCENTRATION RESI-

$

NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	194.2	0.8958	0.0019	0	0.0019
2	194.2	4.0208	0.0017	0	0.0017
3	194.2	10.8264	0.0037	0	0.0037
4	194.2	14.8715	0.0042	0	0.0042
5	194.2	18.0069	0.0037	0	0.0037
6	194.2	21.7778	0.0023	0	0.0023
7	194.2	24.7882	0.0024	0	0.0024
8	194.2	25.809	0.0024	0	0.0024
9	194.2	26.8021	0.0025	0	0.0025
10	194.2	27.0868	0.0024	0	0.0024
11	194.2	27.8785	0.0028	0	0.0028
12	194.2	28.1528	0.0028	0	0.0028
13	194.2	28.75	0.0029	0	0.0029
14	194.2	29.1111	0.0027	0	0.0027
15	194.2	29.7292	0.0031	0	0.0031
16	194.2	30.3229	0.0033	0	0.0033
17	194.2	30.75	0.0036	0	0.0036
18	194.2	31.1389	0.0036	0	0.0036
19	194.2	31.7639	0.0034	0.0001	0.0033
20	194.2	32.1007	0.0035	0.0002	0.0033
21	194.2	32.75	0.0039	0.0007	0.0032
22	194.2	33.0486	0.0041	0.0013	0.0027
23	194.2	33.8264	0.0044	0.0054	-0.001
24	194.2	34.1493	0.0064	0.0089	-0.0025
25	194.2	34.7292	0.0168	0.0197	-0.0029
26	194.2	35.0833	0.0298	0.0302	-0.0004
27	194.2	35.6806	0.0606	0.0558	0.0047
28	194.2	36.1285	0.0898	0.0818	0.008
29	194.2	36.7917	0.1315	0.1283	0.0031
30	194.2	37.1285	0.1559	0.1533	0.0026
31	194.2	37.816	0.1889	0.1994	-0.0105
32	194.2	38.125	0.1944	0.2151	-0.0206
33	194.2	38.8785	0.2315	0.2325	-0.0011
34	194.2	39.1458	0.2352	0.2308	0.0044
35	194.2	39.7882	0.2204	0.2103	0.01
36	194.2	40.191	0.2056	0.1883	0.0173
37	194.2	40.8611	0.1276	0.1432	-0.0157
38	194.2	41.1771	0.1144	0.1212	-0.0068
39	194.2	41.8681	0.0787	0.0774	0.0013
40	194.2	42.2778	0.0578	0.0562	0.0015
41	194.2	42.7917	0.0154	0.0356	-0.0202
42	194.2	44.059	0.0125	0.0089	0.0035
43	194.2	44.8264	0.0065	0.0033	0.0033
44	194.2	45.0868	0.0056	0.0023	0.0034
45	194.2	45.8194	0.0039	0.0007	0.0032
46	194.2	46.7882	0.0027	0.0001	0.0026
47	194.2	47.0903	0.0025	0.0001	0.0025
48	194.2	47.8438	0.0024	0	0.0024
49	194.2	48.8993	0.0021	0	0.0021
50	194.2	49.816	0.0019	0	0.0019
51	194.2	50.8472	0.0018	0	0.0018
52	194.2	51.8611	0.0018	0	0.0018
53	194.2	52.8333	0.0016	0	0.0016
54	194.2	53.8021	0.0016	0	0.0016
55	194.2	54.8576	0.0014	0	0.0014
56	194.2	55.8611	0.0014	0	0.0014
57	194.2	56.7778	0.0015	0	0.0015
58	194.2	57.8438	0.0015	0	0.0015
59	194.2	58.8646	0.0016	0	0.0016
60	194.2	59.8333	0.0019	0	0.0019
61	194.2	60.8125	0.0015	0	0.0015

Table A-12. Test 1 Modified Outlet CXTFIT Data. F) Column 6 (2 pages) (Continued)

C0 Modified

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*******************************************************************
*                                                                 *
*  CXTFIT VERSION 2.1 (4/17/99)                                   *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                   *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                              *
*                                                                 *
*  Comment                                                        *
*  Comment                                                        *
*                                                                 *
*  DATA INPUT FILE: inverse.in                                    *
*                                                                 *
*******************************************************************


MODEL DESCRIPTION
=================
 DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
 RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
 REAL TIME (t), POSITION(x)
  (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V........  .4800E+01   Y
D........  .1830E+02   Y
R........  .1000E+01   N
mu.......  .0000E+00   N


BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =   .5100 & DURATION =   3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM


PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50


ITER   SSQ       V.....   D.....
 0   .5494E+00 .480E+01 .183E+02
 1   .4384E+00 .644E+01 .626E+02
 2   .3627E+00 .618E+01 .313E+02
 3   .2724E+00 .598E+01 .157E+02
 4   .1533E+00 .612E+01 .783E+01
 5   .5298E-01 .611E+01 .392E+01
 6   .4715E-01 .612E+01 .724E+00
 7   .3565E-02 .612E+01 .137E+01
 8   .4961E-03 .612E+01 .165E+01
 9   .4703E-03 .612E+01 .168E+01
10   .4703E-03 .612E+01 .168E+01


COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V.....  D.....
V.....  1.000
D.....  -.078   1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99912001
 (COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) =  .8250E-05


NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
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95% CONFIDENCE LIMITS

NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6120E+01	.1789E-02	.3420E+04	.6116E+01	.6124E+01
D....	.1676E+01	.1766E-01	.9490E+02	.1641E+01	.1712E+01

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	192.8	2.0625	0.0014	0	0.0014
2	192.8	4.0208	0.0014	0	0.0014
3	192.8	10.8333	0.0025	0	0.0025
4	192.8	14.875	0.003	0	0.003
5	192.8	18.0139	0.003	0	0.003
6	192.8	21.7847	0.0021	0	0.0021
7	192.8	25.1215	0.002	0	0.002
8	192.8	25.8194	0.002	0	0.002
9	192.8	26.8125	0.0021	0.0006	0.0015
10	192.8	27.0938	0.0022	0.0012	0.001
11	192.8	27.8889	0.0038	0.0056	-0.0018
12	192.8	28.1597	0.0073	0.0089	-0.0016
13	192.8	28.7604	0.0253	0.0222	0.0031
14	192.8	29.1181	0.0413	0.0354	0.0059
15	192.8	29.7361	0.0734	0.0705	0.0029
16	192.8	30.3299	0.1216	0.1194	0.0022
17	192.8	30.7604	0.1609	0.1623	-0.0014
18	192.8	31.1042	0.2011	0.1986	0.0025
19	192.8	31.7743	0.2626	0.2649	-0.0023
20	192.8	32.1076	0.2942	0.291	0.0032
21	192.8	32.7535	0.3147	0.3192	-0.0045
22	192.8	33.0521	0.3222	0.3204	0.0018
23	192.8	33.8368	0.2942	0.2887	0.0055
24	192.8	34.1563	0.2682	0.2641	0.004
25	192.8	34.7361	0.2142	0.21	0.0041
26	192.8	35.0903	0.1739	0.175	-0.001
27	192.8	35.684	0.1175	0.12	-0.0025
28	192.8	36.1319	0.0823	0.0852	-0.0029
29	192.8	36.7986	0.046	0.0467	-0.0007
30	192.8	37.1354	0.0335	0.0331	0.0004
31	192.8	37.8229	0.0188	0.0151	0.0037
32	192.8	38.1319	0.0141	0.0103	0.0039
33	192.8	38.8854	0.0097	0.0037	0.006
34	192.8	39.1528	0.0077	0.0025	0.0053
35	192.8	39.7986	0.0056	0.0009	0.0047
36	192.8	40.1979	0.0046	0.0005	0.0041
37	192.8	40.8681	0.0039	0.0001	0.0038
38	192.8	41.184	0.0033	0.0001	0.0033
39	192.8	41.875	0.0029	0	0.0029
40	192.8	42.2813	0.0026	0	0.0026
41	192.8	42.8264	0.0027	0	0.0027
42	192.8	44.0625	0.0022	0	0.0022
43	192.8	44.8264	0.0024	0	0.0024
44	192.8	45.8194	0.0023	0	0.0023
45	192.8	47.0938	0.0021	0	0.0021
46	192.8	47.8507	0.002	0	0.002
47	192.8	48.9063	0.0018	0	0.0018
48	192.8	49.8229	0.0017	0	0.0017
49	192.8	50.8542	0.0018	0	0.0018
50	192.8	51.8646	0.0018	0	0.0018
51	192.8	52.8403	0.0015	0	0.0015
52	192.8	53.809	0.0015	0	0.0015
53	192.8	54.8646	0.0014	0	0.0014
54	192.8	55.8646	0.0014	0	0.0014
55	192.8	56.7847	0.0015	0	0.0015
56	192.8	57.8507	0.0015	0	0.0015
57	192.8	58.8715	0.0016	0	0.0016
58	192.8	59.8368	0.0016	0	0.0016
59	192.8	60.8194	0.0014	0	0.0014

Table A-12. Test 1 Modified Outlet CXTFIT Data. G) Column 7 (2 pages) (Continued)

C0 Modified

```
*****************************************************************
*                                              *
*   CXTFIT VERSION 2.1 (4/17/99)                         *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                          *
*                                              *
*   Comment                                     *
*   Comment                                     *
*                                              *
*   DATA INPUT FILE: inverse.in                          *
*                                              *
*****************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V........   .4800E+01     Y
D........   .1830E+02     Y
R........   .1000E+01     N
mu.......   .0000E+00     N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =    .1800 & DURATION =   3.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ       V....    D....
 0   .7120E-01  .480E+01  .183E+02
 1   .6765E-01  .653E+01  .300E+02
 2   .5640E-01  .525E+01  .150E+02
 3   .3312E-01  .582E+01  .750E+01
 4   .1758E-01  .575E+01  .375E+01
 5   .5656E-02  .578E+01  .187E+01
 6   .1648E-02  .580E+01  .654E+00
 7   .8806E-03  .580E+01  .854E+00
 8   .8592E-03  .580E+01  .895E+00
 9   .8591E-03  .580E+01  .898E+00
10   .8591E-03  .580E+01  .898E+00

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....  D....
 V....  1.000
 D....  -.130  1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .98898921
  (COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) =  .1534E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================
```

NAME	VALUE	S.E.COEFF.	T-VALUE	95% CONFIDENCE LIMITS LOWER	UPPER
V....	.5798E+01	.5008E-02	.1158E+04	.5788E+01	.5808E+01
D....	.8978E+00	.3778E-01	.2377E+02	.8221E+00	.9734E+00

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	191.2	2.0625	0.0016	0	0.0016
2	191.2	4.0208	0.0017	0	0.0017
3	191.2	10.8299	0.0094	0	0.0094
4	191.2	14.8715	0.0041	0	0.0041
5	191.2	18.0069	0.0043	0	0.0043
6	191.2	21.7813	0.0023	0	0.0023
7	191.2	24.7917	0.0021	0	0.0021
8	191.2	25.809	0.0022	0	0.0022
9	191.2	26.8056	0.0023	0	0.0023
10	191.2	27.0903	0.0024	0	0.0024
11	191.2	27.8819	0.0028	0	0.0028
12	191.2	28.1528	0.0028	0	0.0028
13	191.2	28.7535	0.0032	0.0001	0.0031
14	191.2	29.1111	0.0032	0.0002	0.003
15	191.2	29.7326	0.0035	0.0009	0.0026
16	191.2	30.3264	0.0038	0.0033	0.0004
17	191.2	30.7535	0.0047	0.0074	-0.0027
18	191.2	31.0972	0.0075	0.013	-0.0055
19	191.2	31.7674	0.0224	0.0317	-0.0093
20	191.2	32.1042	0.0402	0.0453	-0.0051
21	191.2	32.75	0.077	0.0768	0.0002
22	191.2	33.0486	0.0961	0.092	0.0041
23	191.2	33.8264	0.1252	0.1241	0.0011
24	191.2	34.1528	0.1333	0.1313	0.002
25	191.2	34.7292	0.129	0.1318	-0.0028
26	191.2	35.0833	0.1213	0.1244	-0.0031
27	191.2	35.6806	0.0979	0.1015	-0.0036
28	191.2	36.1285	0.0753	0.0798	-0.0044
29	191.2	36.7917	0.0439	0.0484	-0.0045
30	191.2	37.1285	0.0351	0.0351	0
31	191.2	37.816	0.0219	0.0159	0.006
32	191.2	38.1285	0.018	0.0104	0.0076
33	191.2	39.1458	0.0111	0.002	0.0091
34	191.2	39.7917	0.0085	0.0006	0.0079
35	191.2	40.191	0.0073	0.0003	0.007
36	191.2	40.8646	0.0047	0.0001	0.0046
37	191.2	41.1771	0.0046	0	0.0046
38	191.2	41.8681	0.0039	0	0.0039
39	191.2	42.2778	0.0034	0	0.0034
40	191.2	42.8194	0.0027	0	0.0027
41	191.2	44.059	0.0022	0	0.0022
42	191.2	44.8264	0.0024	0	0.0024
43	191.2	45.8194	0.0023	0	0.0023
44	191.2	47.0903	0.0021	0	0.0021
45	191.2	47.8438	0.0021	0	0.0021
46	191.2	48.9028	0.0019	0	0.0019
47	191.2	49.816	0.0018	0	0.0018
48	191.2	50.8472	0.0017	0	0.0017
49	191.2	51.8611	0.0016	0	0.0016
50	191.2	52.8368	0.0016	0	0.0016
51	191.2	53.8056	0.0016	0	0.0016
52	191.2	54.8611	0.0015	0	0.0015
53	191.2	55.8611	0.0015	0	0.0015
54	191.2	56.7813	0.0016	0	0.0016
55	191.2	57.8438	0.0015	0	0.0015
56	191.2	58.8646	0.0016	0	0.0016
57	191.2	59.8333	0.0015	0	0.0015
58	191.2	60.816	0.0015	0	0.0015

Table A-12. Test 1 Modified Outlet CXTFIT Data. H) Column 8 (2 pages) (Continued)

C0 Modified

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: inverse in                                 *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.4800E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = .5400 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.9256E+00	.480E+01	.183E+02
1	.7269E+00	.627E+01	.838E+02
2	.6346E+00	.702E+01	.419E+02
3	.5594E+00	.608E+01	.210E+02
4	.3769E+00	.659E+01	.105E+02
5	.2257E+00	.638E+01	.524E+01
6	.7976E-01	.645E+01	.262E+01
7	.6779E-01	.647E+01	.305E+00
8	.1013E-01	.648E+01	.719E+00
9	.3321E-02	.648E+01	.963E+00
10	.3211E-02	.647E+01	.998E+00
11	.3211E-02	.647E+01	.998E+00

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.121	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99610579
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .5735E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

			95% CONFIDENCE LIMITS		
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6474E+01	.3601E-02	.1798E+04	.6467E+01	.6481E+01
D....	.9979E+00	.2831E-01	.3525E+02	.9412E+00	.1055E+01

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	190.4	4.0208	0.0017	0	0.0017
2	190.4	10.8299	0.0048	0	0.0048
3	190.4	14.8715	0.005	0	0.005
4	190.4	18.0104	0.0039	0	0.0039
5	190.4	21.7813	0.0027	0	0.0027
6	190.4	24.7917	0.0023	0	0.0023
7	190.4	25.816	0.0026	0.0003	0.0023
8	190.4	26.8056	0.0078	0.0057	0.0021
9	190.4	27.0903	0.0139	0.0111	0.0028
10	190.4	27.8854	0.0295	0.0502	-0.0207
11	190.4	28.1563	0.0544	0.0753	-0.0209
12	190.4	28.7535	0.1432	0.155	-0.0117
13	190.4	29.1146	0.2289	0.2157	0.0132
14	190.4	29.7326	0.3315	0.323	0.0085
15	190.4	30.3264	0.4176	0.4015	0.0161
16	190.4	30.7569	0.4359	0.4277	0.0082
17	190.4	31.1007	0.4176	0.426	-0.0084
18	190.4	31.7674	0.3516	0.3677	-0.016
19	190.4	32.1042	0.304	0.3174	-0.0134
20	190.4	32.75	0.2125	0.2072	0.0053
21	190.4	33.0486	0.1659	0.1591	0.0068
22	190.4	33.8299	0.078	0.0649	0.0131
23	190.4	34.1528	0.0522	0.041	0.0112
24	190.4	34.7326	0.0286	0.0158	0.0127
25	190.4	35.0868	0.0185	0.0082	0.0103
26	190.4	35.6806	0.0106	0.0024	0.0083
27	190.4	36.1319	0.0129	0.0008	0.0121
28	190.4	36.7951	0.0053	0.0001	0.0052
29	190.4	37.1319	0.0042	0.0001	0.0042
30	190.4	37.816	0.0033	0	0.0033
31	190.4	38.1285	0.0031	0	0.0031
32	190.4	38.8819	0.0034	0	0.0034
33	190.4	39.1458	0.003	0	0.003
34	190.4	39.7917	0.0028	0	0.0028
35	190.4	40.1944	0.0027	0	0.0027
36	190.4	40.8646	0.0028	0	0.0028
37	190.4	41.1771	0.0025	0	0.0025
38	190.4	41.8681	0.0024	0	0.0024
39	190.4	42.2778	0.0023	0	0.0023
40	190.4	42.8194	0.0022	0	0.0022
41	190.4	44.059	0.0021	0	0.0021
42	190.4	44.8299	0.0021	0	0.0021
43	190.4	45.8229	0.002	0	0.002
44	190.4	47.0938	0.002	0	0.002
45	190.4	47.8472	0.0019	0	0.0019
46	190.4	48.9028	0.0018	0	0.0018
47	190.4	49.8194	0.0018	0	0.0018
48	190.4	50.8507	0.0016	0	0.0016
49	190.4	51.8611	0.0015	0	0.0015
50	190.4	52.8368	0.0015	0	0.0015
51	190.4	53.8056	0.0015	0	0.0015
52	190.4	54.8611	0.0014	0	0.0014
53	190.4	55.8646	0.0014	0	0.0014
54	190.4	56.7813	0.0015	0	0.0015
55	190.4	57.8472	0.0015	0	0.0015
56	190.4	58.8681	0.0015	0	0.0015
57	190.4	59.8368	0.0014	0	0.0014
58	190.4	60.816	0.0014	0	0.0014

Table A-12. Test 1 Modified Outlet CXTFIT Data. I) Column 9 (2 pages) (Continued)

C0 Modified

```
*********************************************************************
*                                                                   *
*   CXTFIT VERSION 2.1 (4/17/99)                                    *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                    *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                               *
*                                                                   *
*   Comment                                                         *
*   Comment                                                         *
*                                                                   *
*   DATA INPUT FILE:  inverse.in                                    *
*                                                                   *
*********************************************************************
```

MODEL DESCRIPTION
=================

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
RESIDENT CONCENTRATION (THIRD-TYPE INPUT)
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================

NAME	INITIAL VALUE	FITTING
V.......	.4800E+01	Y
D.......	.1830E+02	Y
R.......	.1000E+01	N
mu......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
==

SINGLE PULSEOF CONC. = .7500 & DURATION = 3.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.8199E+00	.480E+01	.183E+02
1	.4789E+00	.611E+01	.705E+02
2	.3242E+00	.698E+01	.353E+02
3	.1787E+00	.630E+01	.176E+02
4	.4207E-01	.642E+01	.882E+01
5	.1671E-01	.640E+01	.367E+01
6	.1761E-02	.640E+01	.481E+01
7	.1458E-02	.641E+01	.502E+01
8	.1457E-02	.641E+01	.503E+01
9	.1457E-02	.641E+01	.503E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================

	V....	D....
V....	1.000	
D....	.009	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99786923
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .2557E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
==

			95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.6408E+01	.4464E-02	.1436E+04	.6399E+01	.6417E+01
D....	.5026E+01	.6703E-01	.7498E+02	.4892E+01	.5160E+01

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	187.9	0.8958	0.0016	0	0.0016
2	187.9	4.0208	0.0016	0	0.0016
3	187.9	10.8368	0.0032	0	0.0032
4	187.9	14.8819	0.0036	0	0.0036
5	187.9	18.0139	0.003	0	0.003
6	187.9	21.7951	0.0026	0.0004	0.0022
7	187.9	25.125	0.0296	0.0329	-0.0033
8	187.9	25.8194	0.0566	0.0587	-0.0021
9	187.9	26.816	0.1169	0.1141	0.0028
10	187.9	27.0972	0.1353	0.1332	0.0021
11	187.9	27.8924	0.2004	0.1916	0.0088
12	187.9	28.1632	0.2224	0.2118	0.0107
13	187.9	28.7604	0.2445	0.2536	-0.0091
14	187.9	29.1215	0.2721	0.2756	-0.0035
15	187.9	29.7396	0.2941	0.3042	-0.0101
16	187.9	30.3333	0.3033	0.3183	-0.015
17	187.9	30.7639	0.3143	0.3196	-0.0052
18	187.9	31.1042	0.3143	0.3153	-0.001
19	187.9	31.7743	0.3033	0.2947	0.0086
20	187.9	32.1111	0.2813	0.2792	0.0021
21	187.9	32.7569	0.2555	0.243	0.0126
22	187.9	33.0556	0.2335	0.2244	0.0091
23	187.9	33.8368	0.1768	0.1744	0.0024
24	187.9	34.1597	0.1515	0.1544	-0.0029
25	187.9	34.7396	0.1175	0.1209	-0.0035
26	187.9	35.0938	0.0967	0.1026	-0.0059
27	187.9	35.6875	0.0691	0.076	-0.0068
28	187.9	36.1354	0.0518	0.0593	-0.0075
29	187.9	36.8021	0.0303	0.0399	-0.0095
30	187.9	37.1354	0.0246	0.0322	-0.0076
31	187.9	37.8229	0.0153	0.0203	-0.005
32	187.9	38.1354	0.0126	0.0162	-0.0036
33	187.9	38.8889	0.0081	0.0092	-0.0011
34	187.9	39.1528	0.0073	0.0075	-0.0002
35	187.9	39.8021	0.0055	0.0044	0.0011
36	187.9	40.2014	0.0047	0.0031	0.0015
37	187.9	40.8715	0.0032	0.0017	0.0015
38	187.9	41.184	0.003	0.0013	0.0017
39	187.9	41.875	0.0028	0.0007	0.0021
40	187.9	42.2847	0.0027	0.0005	0.0022
41	187.9	42.8264	0.0022	0.0003	0.0019
42	187.9	44.0625	0.002	0.0001	0.0019
43	187.9	44.8333	0.0021	0	0.002
44	187.9	45.8264	0.0021	0	0.0021
45	187.9	47.0972	0.002	0	0.002
46	187.9	47.8507	0.0019	0	0.0019
47	187.9	48.9063	0.0019	0	0.0019
48	187.9	49.8229	0.0017	0	0.0017
49	187.9	50.8542	0.0017	0	0.0017
50	187.9	51.8646	0.0018	0	0.0018
51	187.9	52.8403	0.0015	0	0.0015
52	187.9	53.809	0.0015	0	0.0015
53	187.9	54.8646	0.0014	0	0.0014
54	187.9	55.8681	0.0014	0	0.0014
55	187.9	56.7847	0.0015	0	0.0015
56	187.9	57.8507	0.0017	0	0.0017
57	187.9	58.8715	0.0016	0	0.0016
58	187.9	59.8403	0.0015	0	0.0015
59	187.9	60.8194	0.0014	0	0.0014

Appendix B. Second Bromide Tracer Test

Table B-1. Test 2 Tracer Application Data.

Column	8/1/02 Begin Pulse	8/2/02 End Pulse
1	3:15 PM	3:15 PM
2	3:00 PM	3:00 PM
3	3:30 PM	3:45 PM
4	3:25 PM	3:30 PM
5	4:00 PM	3:35 PM
6	3:45 PM	3:40 PM
7	4:35 PM	4:20 PM
8	4:50 PM	4:45 PM
9	4:15 PM	4:00 PM

Table B-2. Test 2 Tensimeter Measurements.

Pressure Transducer Values (1 mbar = 1 cm H_2O)

		Columns (values in mbars)								
Date	Time	1	2	3	4	5	6	7	8	9
8/2	8:30a	97	80	157	62	47	52	35	67	79
8/3	9:30a	89	76	141	58	56	50	34	63	58
8/4	2:20p	83	66	155	50	52	60	37	57	85
8/5	5:55a	78	63	148	50	45	56	41	61	74
8/6	5:25a	78	67	162	58	52	59	44	133	81
8/7	5:55a	80	66	169	57	51	60	46	64	80
8/8	5:35a	73	63	148	55	48	56	42	60	75
8/9	6:00a	75	64	148	54	48	55	41	60	76
8/10	5:30a	74	63	134	57	47	58	42	62	94
8/11	8:25a	74	63	139	55	48	55	46	60	73
8/12	8:00a	73	64	162	55	191	52	44	64	72
8/13	7:30a	63	66	167	49	56	55	37	48	68
8/14	8:35a	65	64	167	45	48	51	39	56	61
8/15	8:45a	73	67	172	55	53	56	42	82	93
8/16	7:30a	70	68	161	56	56	55	46	74	67
8/18	8:40a	65	65	161	47	55	61	43	46	79
8/19	9:40a	65	63	158	50	56	58	43	70	77
8/20	8:15a	64	63	156	51	56	48	46	75	71
8/21	8:15a	68	62	176	51	61	52	44	80	76
8/22	8:50a	62	60	166	52	55	47	37	79	73
8/23	8:10a	63	59	162	48	56	45	40	80	76
Avg. measurements		72.95	65.33	157.57	53.10	58.90	54.33	41.38	68.62	75.62

[able B-3. Test 2 Daily and Bulk Average Hydraulic Conductivity Calculations

Hydraulic Conductivity Values (K=(QL/AΔh)*1440) cm/day

Q (mL/min)	0 665
A (cm^2)	182.41

Date	Time	1	2	3	4	5	6	7	8	9			L (cm)
		Columns (values in cm/day)											
8/2	8:30a	12.947	15.635	7.388	23.465	34.559	30.671	74.351	20.824	16.039	hl (cm)	18.5	193.6
8/3	9:30a	14.416	16.669	8.361	25.872	26.480	32.650	80.300	22.717	24.356	h2 (cm)	15.5	192.1
8/4	2:20p	15.757	19.970	7.497	32.548	29.551	24.686	64.758	26.304	14.614	h3 (cm)	19.5	193.5
8/5	5.55a	17.081	21.231	7.905	32.548	37.073	27.355	51.474	23.799	17.459	h4 (cm)	19.0	192.2
8/6	5:25a	17.081	19 582	7.129	25.872	29.551	25.304	44.611	8.768	15.534	h5 (cm)	17.5	194.2
8/7	5:55a	16.526	19.970	6.795	26.552	30.433	24 686	40.969	22.212	15.783	h6 (cm)	19.0	192.8
8/8	5.35a	18.649	21.231	7.905	28.028	33.426	27.355	48.963	24.379	17.155	h7 (cm)	21.5	191.2
8/9	6:00a	17.988	20.793	7.905	28.828	33.426	28.115	51.474	24.379	16.862	h8 (cm)	19.0	190.4
8/10	5:30a	18.313	21.231	8.872	26.552	34.559	25.952	48.963	23.245	12.894	h9 (cm)	17.5	187.9
8/11	8:25a	18.313	21.231	8.501	28.028	33.426	28.115	40.969	24.379	17.773			
8/12	8:00a	18.649	20.793	7.129	28.028	5.876	30.671	44.611	22.212	18.099			
8/13	7:30a	22.839	19.970	6.887	33.633	26.480	28.115	64.758	34.467	19.533			
8/14	8:35a	21.857	20.793	6.887	38.807	33.426	31.630	57 357	27.015	22.676			
8/15	8:45a	18.649	19.582	6.661	28.028	28.718	27.355	48.963	15.866	13.065			
8/16	7:30a	19.735	19.209	7.179	27.270	26.480	28.115	40.969	18.174	19.928			
8/18	8:40a	21.857	20.373	7.179	36.036	27.187	24 099	46.686	37.020	16.039			
8/19	9:40a	21.857	21.231	7.334	32.548	26.480	25.952	46.686	19.599	16.579			
8/20	8:15a	22.337	21.231	7.442	31.531	26.480	34.902	40.969	17.849	18.438			
8/21	8:15a	20.532	21.688	6.491	31.531	23.437	30.671	44.611	16.386	16.862			
8/22	8:50a	23.364	22.662	6.934	30.576	27.187	36.148	64.758	16.659	17.773			
8/23	8:10a	22.8392	23.1832	7.1286	34.7929	26.4804	38.9286	54.2565	16.3860	16.8619			
		19.12	20.39	7.41	30.05	28.61	29.12	52.45	22.03	17.35	Daily avg		

(Average tensimeter values found below are from Table A-2)

1	2	3	4	5	6	7	8	9	
72.95	65.33	157.57	53.10	58.90	54.33	41.38	68.62	75.62	
18.66	20.24	7.36	29.59	24.62	28.65	50.49	20.14	16.97	K w/avg tensimeter values

Table B-4. Test 2 ΔW Values for Effluent Velocity Calculations.

	Water Weights (values in g)									
Time	1	2	3	4	5	6	7	8	9	
8/1/02 14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(empty bottles)
8/2/02 8:30	642.3	618	527.7	659.4	523.8	626.7	593.7	548.4	579	
8/3/02 9:40	897.8	870.3	751.1	899	783.2	890.7	899	795.1	888.1	
8/3/02 16:00	235.4	221.6	255	234.7	200	188.2	233.4	98.2	215.8	
8/4/02 14:30	897	870.9	862.1	908	736.6	881	889.5	1004.6	850.1	
8/5/02 6:05	589.3	562.5	607.2	601.7	502.1	581.5	590.5	577.2	583.6	
8/6/02 5:30	402.3	390.2	401.3	408.3	353.1	394.3	395.7	467.9	391.3	
8/6/02 19:00	511	492	505.4	515.2	440.7	486.9	493.1	578.2	484.8	
8/7/02 7:00	439.3	427.1	435.6	443.9	389.6	427.8	429.8	430.8	425.9	
8/7/02 17:40	442.4	409.7	452.8	443.8	382	418.1	424.1	428.5	422.7	
8/8/02 5:40	442.8	432.1	458.3	445.1	381.4	425.9	433.1	432.9	430.6	
8/8/02 17:30	437	253.5	433.4	441.2	330.7	416.5	420.8	422.8	419.8	
8/9/02 6:05	465.7	452	476.9	473.7	364.2	456	454.5	458.6	452.5	
8/9/02 17:50	435.7	381.8	401.7	446.1	340.8	418.6	414.6	391.8	411.3	
8/10/02 5:35	432.4	429.5	447.9	445.8	347.6	428.1	427.7	439.6	397	
8/10/02 15:15	354.3	343.7	369.8	360.4	277.6	336.5	341.7	346.6	342.4	
8/11/02 8:30	657.4	635.8	631	659.9	528.5	634.2	640.4	643.5	656.1	
8/11/02 18:15	368.9	354	356.6	386.8	290.1	355.6	346.6	353.4	347.9	
8/12/02 8:05	522.3	502.2	495.6	528.6	1.8	503.2	508.1	503.9	496.4	
8/12/02 16:00	289.1	283.2	292.6	290	367.2	266.9	280.1	278.5	277.8	
8/13/02 7:35	589.3	569.2	569.7	595.7	432.6	572.1	575.8	571.3	560.1	
8/13/02 17:10	355.2	341.2	356.6	363.1	251.3	306	338.8	323.1	322.9	
8/14/02 8:40	591.7	574	569.7	598.5	436.4	573.9	335.3	578.73	578.53	
8/14/02 15:20	238.8	225.7	250.7	224.6	165.5	229.8	571	202.3	202.1	
8/15/02 8:50	668.9	640.2	648.6	677.8	501.9	651.4	151.4	658.1	657.9	
8/15/02 17:25	310.8	305.2	327.8	324.6	238.2	303.5	305	295.6	295.4	
8/16/02 7:30	529	499.8	525.2	543.9	413.2	522	527.9	529.1	528.9	
8/16/02 16:45	334.2	323.7	339.6	345.6	250.1	322	319.9	309.4	309.2	
8/18/02 8:45	1172.3	1182.2	1168.1	1165.6	1165.4	1178.2	1180.2	1175.2	1175	
8/18/02 17:35	345.8	329.9	359.6	353.7	256.1	339.2	339.3	330.4	330.2	
8/19/02 9:40	598.1	585	602.8	613.6	485	586.7	599	596.8	596.6	
8/19/02 17:20	277.4	267.1	293.5	283.2	223.9	266.9	273.3	272.3	272.1	
8/20/02 8:20	562.8	544.2	556	571.3	455.6	547.9	555.9	554.4	554.2	
8/20/02 16:20	292.9	278.1	276	293.2	243.6	272.1	281.1	213.5	213.3	
8/21/02 8:20	634.4	609.1	591.2	638.5	609.5	619.6	632.2	616.8	616.6	
8/21/02 15:25	254.4	242	266.5	256.1	240.4	235.6	241.7	238	237.8	
8/22/02 8:55	692	659.5	652.7	691.2	665.9	669.1	684.6	671.2	671	
8/23/02 8:15	896.6	856.3	873.3	892	859.2	853.8	884.3	870.7	870.5	
Sums	18807.0	17962.5	18389.6	19023.8	15434.8	18186.5	18013.1	18207.4	18065.4	
Bulk avg v (cm/day)	13.55	12.94	13.25	13.71	11.12	13.10	12.98	13.12	13.02	
Total time (day)	21.74									

v=ΔW/Antρ

n	0.35	A (cm^2)	182.4

Table B-5. Test 2 Daily Effluent Velocity Values.

	Rate (cm/day) (0.665 mL/min equals 15 cm/day)								
Day Fraction	1	2	3	4	5	6	7	8	9
0.75	13.415	12.907	11.021	13.772	10.940	13.089	12.400	11.454	12.093
1.05	13.411	13.001	11.220	13.429	11.699	13.305	13.429	11.877	13.266
0.26	13.973	13.154	15.137	13.932	11.872	11.171	13.854	5.829	12.810
0.94	14.987	14.551	14.404	15.171	12.307	14.720	14.862	16.785	14.204
0.65	14.217	13.570	14.648	14.516	12.113	14.028	14.246	13.925	14.079
0.98	6.459	6.264	6.443	6.555	5.669	6.330	6.353	7.512	6.282
0.56	14.230	13.701	14.074	14.347	12.272	13.559	13.732	16.101	13.500
0.50	13.763	13.380	13.647	13.907	12.206	13.402	13.465	13.496	13.343
0.44	15.592	14.440	15.959	15.641	13.463	14.736	14.947	15.102	14.898
0.50	13.872	13.537	14.358	13.944	11.949	13.343	13.568	13.562	13.490
0.49	13.883	8.054	13.769	14.017	10.506	13.232	13.369	13.432	13.337
0.52	13.913	13.504	14.248	14.152	10.881	13.623	13.579	13.701	13.519
0.49	13.940	12.216	12.852	14.273	10.904	13.393	13.265	12.536	13.159
0.49	13.835	13.742	14.331	14.263	11.121	13.697	13.684	14.065	12.702
0.40	13.779	13.367	14.382	14.016	10.796	13.087	13.289	13.479	13.316
0.72	14.327	13.856	13.752	14.382	11.518	13.822	13.957	14.024	14.299
0.41	14.224	13.650	13.750	14.914	11.186	13.711	13.364	13.626	13.414
0.58	14.194	13.648	13.469	14.365	0.049	13.675	13.808	13.694	13.490
0.33	13.729	13.448	13.895	13.771	17.437	12.674	13.301	13.225	13.192
0.65	14.217	13.732	13.744	14.371	10.436	13.802	13.891	13.782	13.512
0.40	13.934	13.385	13.989	14.244	9.858	12.004	13.291	12.675	12.667
0.65	14.351	13.922	13.818	14.516	10.585	13.919	8.132	14.037	14.032
0.28	13.466	12.727	14.137	12.665	9.333	12.959	32.199	11.408	11.397
0.73	14.369	13.753	13.933	14.561	10.782	13.994	3.252	14.137	14.133
0.36	13.613	13.367	14.357	14.217	10.433	13.293	13.359	12.947	12.938
0.59	14.121	13.342	14.020	14.519	11.030	13.934	14.092	14.124	14.118
0.39	13.583	13.156	13.802	14.046	10.165	13.087	13.001	12.575	12.567
1.67	11.018	11.111	10.978	10.955	10.953	11.073	11.092	11.045	11.043
0.37	14.717	14.040	15.304	15.053	10.899	14.436	14.440	14.062	14.053
0.67	13.980	13.674	14.090	14.343	11.337	13.714	14.001	13.950	13.945
0.32	13.602	13.097	14.392	13.887	10.979	13.088	13.401	13.352	13.343
0.63	14.105	13.639	13.935	14.318	11.419	13.732	13.932	13.895	13.890
0.33	13.764	13.069	12.970	13.778	11.447	12.787	13.210	10.033	10.023
0.67	14.906	14.312	13.891	15.002	14.321	14.558	14.854	14.492	14.488
0.30	13.502	12.844	14.144	13.592	12.759	12.504	12.828	12.632	12.621
0.73	14.866	14.168	14.021	14.849	14.305	14.374	14.707	14.419	14.415
0.97	14.446	13.796	14.070	14.372	13.843	13.756	14.248	14.028	14.025
Daily avg v (cm/day)	13.79	13.11	13.65	13.96	11.18	13.23	13.52	13.11	13.12
Total time (day)									
21.74									

$v = \Delta W / A n t \rho$

n 0.35 A (cm^2) 182.4

Table B-6. Test 2 Outlet Data. A) Column 1

Column # 1 Outlet				Location (cm)	193.6	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 15:15	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:00a	8/2/02 9:00	0.74	96.6	0.828	130.5	1080	0.0015
8/3	2	10:00a	8/3/02 10:00	1.78	96.6	0.779	132	1080	0.0014
8/4	3	2:55p	8/4/02 14:55	2.99	93.6	0.969	126.1	1000	0.0018
8/5	4	6:25a	8/5/02 6:25	3.63	93.6	1.03	124.6	1010	0.0019
8/6	5	5:55a	8/6/02 5:55	4.61	93.6	1.15	122.7	982	0.0021
8/7	6	6:25a	8/7/02 6:25	5.63	93.6	1.13	123.1	1010	0.0021
8/7	6	5:55p	8/7/02 17:55	6.11	93.3	1.11	119.4	1030	0.0021
8/8	7	6:05a	8/8/02 6:05	6.62	93.3	1.07	120.3	1040	0.0020
8/8	7	5:45p	8/8/02 17:45	7.10	94.6	1.16	121	1020	0.0022
8/9	8	6:30a	8/9/02 6:30	7.64	94.6	1.91	108.7	1020	0.0036
8/9	8	6:05p	8/9/02 18:05	8.12	94.4	4.3	87.2	1060	0.0080
8/10	9	6:00a	8/10/02 6:00	8.61	94.4	12	62	1010	0.0223
8/10	9	3:35p	8/10/02 15:35	9.01	94.4	24.1	45.1	1030	0.0448
8/11	10	8:50a	8/11/02 8:50	9.73	94.4	58.8	23.4	1060	0.1093
8/11	10	6:30p	8/11/02 18:30	10.14	93.9	68.4	17.6	1090	0.1271
8/12	11	8:25a	8/12/02 8:25	10.72	93.9	87.5	11..6	1180	0.1626
8/12	11	4:20p	8/12/02 16:20	11.05	94.1	92.5	10.3	1160	0.1719
8/13	12	8:00a	8/13/02 8:00	11.70	94.1	101	8.3	1130	0.1877
8/13	12	5:25p	8/13/02 17:25	12.09	92.4	94.2	8.8	1210	0.1751
8/14	13	9:00a	8/14/02 9:00	12.74	92.4	89.5	10.1	1200	0.1664
8/14	13	3:45p	8/14/02 15:45	13.02	93.8	81.7	12.5	1030	0.1519
8/15	14	9:10a	8/15/02 9:10	13.75	93.8	68.9	16.7	1040	0.1281
8/15	14	5:40p	8/15/02 17:40	14.10	95.6	55.6	22.6	1000	0.1033
8/16	15	7:55a	8/16/02 7:55	14.69	95.6	31.3	36.8	1010	0.0582
8/16	15	5:05p	8/16/02 17:05	15.08	95.6	18.2	50.2	965	0.0338
8/17	16	10:05a	8/17/02 10:05	15.78	95.1	4.65	83.6	980	0.0086
8/17	16	5:25p	8/17/02 17:25	16.09	95.1	2.92	94.9	953	0.0054
8/18	17	9:10a	8/18/02 9:10	16.75	95.1	1.64	109.1	904	0.0030
8/18	17	5:50p	8/18/02 17:50	17.11	93.3	1.54	110.2	922	0.0029
8/19	18	10:05a	8/19/02 10:05	17.78	93.3	1.31	114.1	926	0.0024
8/19	18	5:40p	8/19/02 17:40	18.10	93.3	1.2	116.2	905	0.0022
8/20	19	9:20a	8/20/02 9:20	18.75	93.3	1.13	117.6	835	0.0021
8/21	20	8:40a	8/21/02 8:40	19.73	96.6	1.1	119.4	1280	0.0020
8/22	21	9:40a	8/22/02 9:40	20.77	96.6	1.06	120.2	1220	0.0020
8/23	22	8:40a	8/23/02 8:40	21.73	96.6	0.973	122.4	1230	0.0018

(Table continued on next page)

Table B-6. Test 2 Outlet Data. B) Column 2 (Continued)

Column # 2 Outlet				Location (cm)	192.1	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 15:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:10a	8/2/02 9:10	0.76	96.6	0.746	133.1	1060	0.0014
8/3	2	10:10a	8/3/02 10:10	1.80	96.6	0.751	132.9	1060	0.0014
8/4	3	3:00p	8/4/02 15:00	3.00	93.6	1.05	124.1	1070	0.0020
8/5	4	6:35a	8/5/02 6:35	3.65	93.6	1.04	124.4	1030	0.0019
8/6	5	6:10a	8/6/02 6:10	4.63	93.6	1.08	124.1	991	0.0020
8/7	6	6:35a	8/7/02 6:35	5.65	93.6	1.13	123.1	1010	0.0021
8/7	6	6:00p	8/7/02 18:00	6.13	93.3	0.973	122.5	1020	0.0018
8/8	7	6:15a	8/8/02 6:15	6.64	93.3	1.06	120.4	1060	0.0020
8/8	7	5:55p	8/8/02 17:55	7.12	94.6	1.32	117.7	1030	0.0025
8/9	8	6:45a	8/9/02 6:45	7.66	94.6	1.36	117.1	1040	0.0025
8/9	8	6:15p	8/9/02 18:15	8.14	94.4	1.97	106.6	1060	0.0037
8/10	9	6:10a	8/10/02 6:10	8.63	94.4	5.09	83	995	0.0095
8/10	9	3:40p	8/10/02 15:40	9.03	94.4	12	61.9	1030	0.0223
8/11	10	9:00a	8/11/02 9:00	9.75	94.4	40.4	32.5	1070	0.0751
8/11	10	6:35p	8/11/02 18:35	10.15	93.9	54.2	23.2	1140	0.1007
8/12	11	8:35a	8/12/02 8:35	10.73	93.9	75.9	15.1	1150	0.1411
8/12	11	4:25p	8/12/02 16:25	11.06	94.1	88.4	11.4	1150	0.1643
8/13	12	8:10a	8/13/02 8:10	11.72	94.1	95.5	9.5	1150	0.1775
8/13	12	5:30p	8/13/02 17:30	12.10	92.4	88.7	10.3	1150	0.1649
8/14	13	9:10a	8/14/02 9:10	12.76	92.4	84.4	11.5	1160	0.1569
8/14	13	3:45p	8/14/02 15:45	13.03	93.8	81.5	12.6	1030	0.1515
8/15	14	9:20a	8/15/02 9:20	13.76	93.8	72	15.6	1020	0.1338
8/15	14	5:50p	8/15/02 17:50	14.12	95.6	65.9	18.4	1010	0.1225
8/16	15	8:00a	8/16/02 8:00	14.71	95.6	53.3	23.6	1020	0.0991
8/16	15	5:10p	8/16/02 17:10	15.09	95.6	40.1	30.7	1010	0.0745
8/17	16	10:20a	8/17/02 10:20	15.81	95.1	16.9	51.8	994	0.0314
8/17	16	5:30p	8/17/02 17:30	16.10	95.1	11.6	61.1	994	0.0216
8/18	17	9:20a	8/18/02 9:20	16.76	95.1	4.58	83.9	944	0.0085
8/18	17	5:55p	8/18/02 17:55	17.12	93.3	2.99	94.3	934	0.0056
8/19	18	10:10a	8/19/02 10:10	17.80	93.3	1.58	107.7	935	0.0029
8/19	18	5:45p	8/19/02 17:45	18.11	93.3	1.35	113.4	920	0.0025
8/20	19	9:30a	8/20/02 9:30	18.77	93.3	1.15	117.3	885	0.0021
8/21	20	8:50a	8/21/02 8:50	19.74	96.6	1.02	121.3	1210	0.0019
8/22	21	9:50a	8/22/02 9:50	20.78	96.6	0.973	122.3	1230	0.0018
8/23	22	8:45a	8/23/02 8:45	21.74	96.6	0.98	122.2	1220	0.0018

Table B-6. Test 2 Outlet Data. C) Column 3 (Continued)

Column # 3 Outlet				Location (cm)	193.5	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 15:30	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:10a	8/2/02 9:10	0.74	96.6	0.724	133.8	1060	0.0013
8/3	2	10:10a	8/3/02 10:10	1.78	96.6	0.76	132.6	1040	0.0014
8/4	3	3:05p	8/4/02 15:05	2.98	93.6	1.04	124.5	1030	0.0019
8/5	4	6:35a	8/5/02 6:35	3.63	93.6	1.01	125.1	1080	0.0019
8/6	5	6:10a	8/6/02 6:10	4.61	93.6	1.04	125	985	0.0019
8/7	6	6:35a	8/7/02 6:35	5.63	93.6	1.15	122.5	990	0.0021
8/7	6	6:05p	8/7/02 18:05	6.11	93.3	1.06	120.5	1030	0.0020
8/8	7	6:20a	8/8/02 6:20	6.62	93.3	1.07	120.3	1050	0.0020
8/8	7	6:00p	8/8/02 18:00	7.10	94.6	1.36	117.1	1080	0.0025
8/9	8	6:45a	8/9/02 6:45	7.64	94.6	1.32	117.8	1070	0.0025
8/9	8	6:20p	8/9/02 18:20	8.12	94.4	1.28	117.3	1110	0.0024
8/10	9	6:15a	8/10/02 6:15	8.61	94.4	1.36	115.7	938	0.0025
8/10	9	3:50p	8/10/02 15:50	9.01	94.4	2.07	105.3	1020	0.0038
8/11	10	9:05a	8/11/02 9:05	9.73	94.4	12.5	60.9	1020	0.0232
8/11	10	6:45p	8/11/02 18:45	10.14	93.9	24.9	42	1080	0.0463
8/12	11	8:40a	8/12/02 8:40	10.72	93.9	52.8	23.9	1080	0.0981
8/12	11	4:30p	8/12/02 16:30	11.04	94.1	75.4	15.3	1100	0.1401
8/13	12	8:15a	8/13/02 8:15	11.70	94.1	101	8.2	1150	0.1877
8/13	12	5:40p	8/13/02 17:40	12.09	92.4	105	6.3	1190	0.1952
8/14	13	9:15a	8/14/02 9:15	12.74	92.4	111	5	1200	0.2063
8/14	13	3:55p	8/14/02 15:55	13.02	93.8	111	5.2	1060	0.2063
8/15	14	9:25a	8/15/02 9:25	13.75	93.8	102	7.2	1040	0.1896
8/15	14	5:55p	8/15/02 17:55	14.10	95.6	80.7	13.4	1020	0.1500
8/16	15	8:05a	8/16/02 8:05	14.69	95.6	35.8	33.5	1000	0.0665
8/16	15	5:15p	8/16/02 17:15	15.07	95.6	16.4	52.9	1010	0.0305
8/17	16	10:10a	8/17/02 10:10	15.78	95.1	3.3	91.9	1010	0.0061
8/17	16	5:20p	8/17/02 17:20	16.08	95.1	2.16	102.3	995	0.0040
8/18	17	9:25a	8/18/02 9:25	16.75	95.1	1.54	110.6	945	0.0029
8/18	17	6:00p	8/18/02 18:00	17.10	93.3	1.4	112.1	948	0.0026
8/19	18	10:15a	8/19/02 10:15	17.78	93.3	1.36	113.3	925	0.0025
8/19	18	5:55p	8/19/02 17:55	18.10	93.3	1.32	113.9	922	0.0025
8/20	19	9:30a	8/20/02 9:30	18.75	93.3	1.23	115.6	848	0.0023
8/21	20	8:55a	8/21/02 8:55	19.73	96.6	1	121.7	1210	0.0019
8/22	21	9:45a	8/22/02 9:45	20.76	96.6	0.989	122	1200	0.0018
8/23	22	8:50a	8/23/02 8:50	21.72	96.6	1.01	121.6	1190	0.0019

Peak day avg 12.88

Table B-6. Test 2 Outlet Data. D) Column 4 (Continued)

Column # 4 Outlet				Location (cm)	192.2	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 15:25	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:10a	8/2/02 9:10	0.74	96.6	0.735	133.4	1080	0.0014
8/3	2	10:10a	8/3/02 10:10	1.78	96.6	0.746	133.1	1070	0.0014
8/4	3	3:00p	8/4/02 15:00	2.98	93.6	1.01	125.0	1020	0.0019
8/5	4	6:35a	8/5/02 6:35	3.63	93.6	1.02	124.8	1040	0.0019
8/6	5	6:05a	8/6/02 6:05	4.61	93.6	1.05	124.7	969	0.0020
8/7	6	6:35a	8/7/02 6:35	5.63	93.6	1.17	122.3	1030	0.0022
8/7	6	6:00p	8/7/02 18:00	6.11	93.3	0.994	122.0	1010	0.0018
8/8	7	6:15a	8/8/02 6:15	6.62	93.3	1.08	120.0	1040	0.0020
8/8	7	5:50p	8/8/02 17:50	7.10	94.6	1.27	118.7	1070	0.0024
8/9	8	6:40a	8/9/02 6:40	7.64	94.6	1.78	110.4	1050	0.0033
8/9	8	6:10p	8/9/02 18.10	8.11	94.4	3.95	89.3	1030	0.0073
8/10	9	6:10a	8/10/02 6:10	8.61	94.4	8.3	70.9	1000	0.0154
8/10	9	3:40p	8/10/02 15:40	9.01	94.4	14.3	57.7	1050	0.0266
8/11	10	9:10a	8/11/02 9:10	9.74	94.4	22.2	48.7	1000	0.0413
8/11	10	6:35p	8/11/02 18:35	10.13	93.9	55.6	22.6	1100	0.1033
8/12	11	8:35a	8/12/02 8:35	10.72	93.9	91.2	10.6	1150	0.1695
8/12	11	4:35p	8/12/02 16:35	11.05	94.1	108	6.6	1160	0.2007
8/13	12	8:10a	8/13/02 8:10	11.70	94.1	127	2.7	1140	0.2361
8/13	12	5:30p	8/13/02 17:30	12.09	92.4	126	2.0	1240	0.2342
8/14	13	9:40a	8/14/02 9:40	12.76	92.4	110	5.3	1240	0.2045
8/14	13	3:50p	8/14/02 15:50	13.02	93.8	96.4	8.5	1060	0.1792
8/15	14	9:20a	8/15/02 8:20	13.70	93.8	57.5	21.1	1020	0.1069
8/15	14	5:50p	8/15/02 17:50	14.10	95.6	43.3	28.8	998	0.0805
8/16	15	8:05a	8/16/02 8:05	14.69	95.6	21.4	46.2	935	0.0398
8/16	15	5:15p	8/16/02 17:15	15.08	95.6	12.3	60.0	996	0.0229
8/17	16	10:20a	8/17/02 10:20	15.79	95.1	4.12	86.5	1010	0.0077
8/17	16	5:35p	8/17/02 17:35	16.09	95.1	3.24	92.4	994	0.0060
8/18	17	9:15a	8/18/02 9:15	16.74	95.1	2.12	102.7	932	0.0039
8/18	17	5:55p	8/18/02 17:55	17.10	93.3	2.05	103.4	925	0.0038
8/19	18	10:10a	8/19/02 10:10	17.78	93.3	1.66	108.5	895	0.0031
8/19	18	5:45p	8/19/02 17:45	18.10	93.3	1.5	110.8	926	0.0028
8/20	19	9:25a	8/20/02 9:25	18.75	93.3	1.29	114.5	883	0.0024
8/21	20	8:45a	8/21/02 8:45	19.72	96.6	1.07	120.0	1230	0.0020
8/22	21	9:55a	8/22/02 9:55	20.77	96.6	1.03	120.9	1220	0.0019
8/23	22	8:45a	8/23/02 8:45	21.72	96.6	1	121.7	1250	0.0019

Table B-6. Test 2 Outlet Data. E) Column 5 (Continued)

Column # 5 Outlet				Location (cm)	194.2	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 16:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:00a	8/2/02 9:00	0.71	96.6	0.707	134.4	1040	0.0013
8/3	2	10:00a	8/3/02 10:00	1.75	96.6	0.728	133.7	1050	0.0014
8/4	3	2:55p	8/4/02 14:55	2.95	93.6	1.02	124.9	1040	0.0019
8/5	4	6:25a	8/5/02 6:25	3.60	93.6	0.969	126.1	1090	0.0018
8/6	5	6:00a	8/6/02 6:00	4.58	93.6	1.02	125.5	1000	0.0019
8/7	6	6:25a	8/7/02 6:25	5.60	93.6	1.05	124.8	1000	0.0020
8/7	6	5:55p	8/7/02 17:55	6.08	93.3	0.92	123.9	1020	0.0017
8/8	7	6:05a	8/8/02 6:05	6.59	93.3	0.994	122.0	1040	0.0018
8/8	7	5:45p	8/8/02 17:45	7.07	94.6	1.24	119.4	1050	0.0023
8/9	8	6:35a	8/9/02 6:35	7.61	94.6	1.21	119.7	1050	0.0022
8/9	8	6:05p	8/9/02 18:05	8.09	94.4	1.25	117.9	1040	0.0023
8/10	9	6:05a	8/10/02 6:05	8.59	94.4	1.24	118.1	1010	0.0023
8/10	9	3:35p	8/10/02 15:35	8.98	94.4	1.23	118.2	1030	0.0023
8/11	10	8:50a	8/11/02 8:50	9.70	94.4	1.47	113.9	1070	0.0027
8/11	10	6:30p	8/11/02 18:30	10.10	93.9	2.47	98.9	1020	0.0046
8/12	11	8:25a	8/12/02 8:25	10.68	93.9	2.74	96.3	1060	0.0051
8/12	11	4:20p	8/12/02 16:20	11.01	94.1	11.1	62.3	1050	0.0206
8/13	12	8:00a	8/13/02 8:00	11.67	94.1	35.9	33.5	1080	0.0667
8/13	12	5:25p	8/13/02 17:05	12.05	92.4	62.9	18.8	1120	0.1169
8/14	13	9:05a	8/14/02 9:05	12.71	92.4	103	6.9	1170	0.1914
8/14	13	3:45p	8/14/02 15:45	12.99	93.8	116	4.0	1050	0.2156
8/15	14	9:15a	8/15/02 9:15	13.72	93.8	134	0.6	1030	0.2491
8/15	14	5:40p	8/15/02 17:40	14.07	95.6	136	0.6	1020	0.2528
8/16	15	7:55a	8/16/02 7:55	14.66	95.6	123	3.1	1050	0.2286
8/16	15	5:05p	8/16/02 17:05	15.05	95.6	110	5.8	1040	0.2045
8/17	16	10:15a	8/17/02 10:15	15.76	95.1	69.7	16.5	1070	0.1296
8/17	16	5:25p	8/17/02 17:25	16.06	95.1	54.7	22.5	1050	0.1017
8/18	17	9:10a	8/18/02 9:10	16.72	95.1	27.3	39.8	971	0.0507
8/18	17	5:50p	8/18/02 17:50	17.08	93.3	15.6	54.5	963	0.0290
8/19	18	10:05a	8/19/02 10:05	17.75	93.3	5.79	78.5	947	0.0108
8/19	18	5:45p	8/19/02 17:45	18.07	93.3	3.98	87.5	936	0.0074
8/20	19	9:20a	8/20/02 9:20	18.72	93.3	2.4	99.6	878	0.0045
8/21	20	8:40a	8/21/02 8:40	19.69	96.6	1.28	115.5	1220	0.0024
8/22	21	9:40a	8/22/02 9:40	20.74	96.6	1.09	119.6	1280	0.0020
8/23	22	8:40a	8/23/02 8:40	21.69	96.6	1.01	121.6	1230	0.0019

Table B-6. Test 2 Outlet Data. F) Column 6 (Continued)

Column # 6 Outlet				Location (cm)	192.8	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 15:45	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:10a	8/2/02 9:10	0.73	96.6	0.712	134.2	1060	0.0013
8/3	2	10:10a	8/3/02 10:10	1.77	96.6	0.734	133.5	1050	0.0014
8/4	3	3:00p	8/4/02 15:00	2.97	93.6	0.973	126.0	1020	0.0018
8/5	4	6:35a	8/5/02 6:35	3.62	93.6	0.949	126.6	1060	0.0018
8/6	5	6:05a	8/6/02 6:05	4.60	93.6	1.12	123.3	1010	0.0021
8/7	6	6:35a	8/7/02 6:35	5.62	93.6	1.13	123	1020	0.0021
8/7	6	6:00p	8/7/02 18:00	6.09	93.3	0.967	122.7	1040	0.0018
8/8	7	6:15a	8/8/02 6:15	6.60	93.3	0.987	122.2	1040	0.0018
8/8	7	5:50p	8/8/02 17:50	7.09	94.6	1.03	123.8	1040	0.0019
8/9	8	6:40a	8/9/02 6:40	7.62	94.6	1.17	120.7	1040	0.0022
8/9	8	6:15p	8/9/02 18:15	8.10	94.4	1.25	117.7	1040	0.0023
8/10	9	6:10a	8/10/02 6:10	8.60	94.4	1.45	114.2	995	0.0027
8/10	9	3:40p	8/10/02 15:40	9.00	94.4	3.14	95	1060	0.0058
8/11	10	8:55a	8/11/02 8:55	9.72	94.4	17.7	52.5	1050	0.0329
8/11	10	6:35p	8/11/02 18:35	10.12	93.9	33.7	34.7	1050	0.0626
8/12	11	8:35a	8/12/02 8:35	10.70	93.9	68.4	17.6	1120	0.1271
8/12	11	4:25p	8/12/02 16:25	11.03	94.1	84.8	12.4	1080	0.1576
8/13	12	8:05a	8/13/02 8:05	11.68	94.1	118	4.5	1150	0.2193
8/13	12	5:30p	8/13/02 17:30	12.07	92.4	121	3	1160	0.2249
8/14	13	9:10a	8/14/02 9:10	12.73	92.4	118	3.5	1200	0.2193
8/14	13	3:50p	8/14/02 15:50	13.00	93.8	111	5.2	1050	0.2063
8/15	14	9:20a	8/15/02 9:20	13.73	93.8	89.5	10.3	1050	0.1664
8/15	14	5:45p	8/15/02 17:45	14.08	95.6	82.6	12.8	110	0.1535
8/16	15	8:00a	8/16/02 8:00	14.68	95.6	56.5	22.2	1040	0.1050
8/16	15	5:10p	8/16/02 17:10	15.06	95.6	32.7	35.8	1020	0.0608
8/17	16	10:25a	8/17/02 10:25	15.78	95.1	13.5	57.4	1010	0.0251
8/17	16	5:35p	8/17/02 17:35	16.08	95.1	8.65	68.4	1010	0.0161
8/18	17	9:15a	8/18/02 9:15	16.73	95.1	3.35	91.6	925	0.0062
8/18	17	5:55p	8/18/02 17:55	17.09	93.3	2.4	99.6	892	0.0045
8/19	18	10:10a	8/19/02 10:10	17.77	93.3	1.6	109.4	938	0.0030
8/19	18	5:45p	8/19/02 17:45	18.08	93.3	1.4	112.5	927	0.0026
8/20	19	9:25a	8/20/02 9:25	18.74	93.3	1.27	114.8	869	0.0024
8/21	20	8:50a	8/21/02 8:50	19.71	96.6	1.01	121.4	1210	0.0019
8/22	21	9:50a	8/22/02 9:50	20.75	96.6	0.965	122.6	1190	0.0018
8/23	22	8:45a	8/23/02 8:45	21.71	96.6	0.872	125.1	1220	0.0016

Table B-6. Test 2 Outlet Data. G) Column 7 (Continued)

Column # 7 Outlet				Location (cm)	191.2	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 16:35	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:05a	8/2/02 9:05	0.69	96.6	0.751	132.9	1060	0.0014
8/3	2	10:05a	8/3/02 10:05	1.73	96.6	0.731	133.7	1060	0.0014
8/4	3	2:55p	8/4/02 14:55	2.93	96.6	0.987	125.7	1040	0.0018
8/5	4	6:30a	8/5/02 6:30	3.58	96.6	0.989	125.6	1060	0.0018
8/6	5	6:00a	8/6/02 6:00	4.56	96.6	1.06	124.5	1000	0.0020
8/7	6	6:25a	8/7/02 6:25	5.58	96.6	1.17	122.3	1030	0.0022
8/7	6	5:55p	8/8/02 17:55	7.06	96.6	0.934	123.5	1030	0.0017
8/8	7	6:10a	8/9/02 18:10	8.07	96.6	0.939	123.1	1040	0.0017
8/8	7	5:45p	8/8/02 17:45	7.05	94.6	1.09	122.4	1040	0.0020
8/9	8	6:35a	8/9/02 6:35	7.58	94.6	1.21	119.9	1050	0.0022
8/9	8	6:05p	8/9/02 18:05	8.06	94.4	1.34	116.1	1070	0.0025
8/10	9	6:05a	8/10/02 6:05	8.56	94.4	1.41	114.8	997	0.0026
8/10	9	3:35p	8/10/02 15:35	8.96	94.4	2.24	103.3	1050	0.0042
8/11	10	8:50a	8/11/02 8:50	9.68	94.4	13.1	59.8	1050	0.0243
8/11	10	6:30p	8/11/02 18:30	10.08	93.9	28.5	38.8	1080	0.0530
8/12	11	8:30a	8/12/02 8:30	10.66	93.9	68.4	17.6	1120	0.1271
8/12	11	4:20p	8/12/02 16:20	10.99	94.1	92.9	10.2	1120	0.1727
8/13	12	8:00a	8/13/02 8:00	11.64	94.1	130	2.1	1150	0.2416
8/13	12	5:25p	8/13/02 17:25	12.03	92.4	137	0.1	1220	0.2546
8/14	13	9:05a	8/14/02 9:05	12.69	92.4	135	0.4	1240	0.2509
8/14	13	3:45p	8/14/02 15:45	12.97	93.8	126	2.1	1060	0.2342
8/15	14	9:15a	8/15/02 9:15	13.69	93.8	87.3	10.9	1040	0.1623
8/15	14	5:40p	8/15/02 17:40	14.05	95.6	64	19.1	1000	0.1190
8/16	15	7:55a	8/16/02 7:55	14.64	95.6	27.4	40.1	1020	0.0509
8/16	15	5:05p	8/16/02 17:05	15.02	95.6	14.4	56.1	1000	0.0268
8/17	16	10:20a	8/17/02 10:20	15.74	95.1	4.26	85.7	1010	0.0079
8/17	16	5:30p	8/17/02 17:30	16.04	95.1	3.13	93.2	1000	0.0058
8/18	17	9:10a	8/18/02 9:10	16.69	95.1	2.04	103.7	952	0.0038
8/18	17	5:50p	8/18/02 17:50	17.05	93.3	1.9	105.3	933	0.0035
8/19	18	10:05a	8/19/02 10:05	17.73	93.3	1.63	108.9	915	0.0030
8/19	18	5:45p	8/19/02 17:45	18.05	93.3	1.47	111.4	913	0.0027
8/20	19	9:20a	8/20/02 9:20	18.70	93.3	1.29	114.6	881	0.0024
8/21	20	8:45a	8/21/02 8:45	19.67	96.6	0.862	125.4	1230	0.0016
8/22	21	9:40a	8/22/02 9:40	20.71	96.6	0.872	125.1	1210	0.0016
8/23	22	8:40a	8/23/02 8:40	21.67	96.6	0.856	125.6	1240	0.0016

Table B-6. Test 2 Outlet Data. H) Column 8 (Continued)

Column # 8 Outlet				Location (cm)	190.4	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 16:50	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:05a	8/2/02 9:05	0.68	96.6	0.724	133.8	1070	0.0013
8/3	2	10:05a	8/3/02 10:05	1.72	96.6	0.755	132.8	1060	0.0014
8/4	3	2:00p	8/4/02 14:00	2.88	93.6	0.989	125.6	1020	0.0018
8/5	4	6:30a	8/5/02 6:30	3.57	93.6	0.967	126.1	1030	0.0018
8/6	5	6:00a	8/6/02 6:00	4.55	93.6	1.18	122.1	985	0.0022
8/7	6	6:30a	8/7/02 6:30	5.57	93.6	1.2	121.5	1050	0.0022
8/7	6	6:00p	8/7/02 18:00	6.05	93.3	1.07	120.2	1070	0.0020
8/8	7	6:10a	8/8/02 6:10	6.56	93.3	1.05	120.6	1060	0.0020
8/8	7	5:50p	8/8/02 17:50	7.04	94.6	1.24	119.3	1050	0.0023
8/9	8	6:35a	8/9/02 6:35	7.57	94.6	1.19	120.2	1050	0.0022
8/9	8	6:10p	8/9/02 18:10	8.06	94.4	1.32	116.5	1030	0.0025
8/10	9	6:15a	8/10/02 6:15	8.56	94.4	1.76	109.3	940	0.0033
8/10	9	3:40p	8/10/02 15:40	8.95	94.4	3.6	91.6	1030	0.0067
8/11	10	8:55a	8/11/02 8:55	9.67	94.4	19.9	49.7	1050	0.0370
8/11	10	6:35p	8/11/02 18:35	10.07	93.9	40.9	30	1070	0.0760
8/12	11	8:30a	8/12/02 8:30	10.65	93.9	86.2	12	1110	0.1602
8/12	11	4:20p	8/12/02 16:20	10.98	94.1	109	6.4	1080	0.2026
8/13	12	8:05a	8/13/02 8:05	11.64	94.1	129	2.3	1170	0.2398
8/13	12	5:30p	8/13/02 17:30	12.03	92.4	122	2.7	1180	0.2268
8/14	13	9:25a	8/14/02 9:25	12.69	92.4	94.6	8.8	1240	0.1758
8/14	13	3:50p	8/14/02 15:50	12.96	93.8	87.7	10.8	1060	0.1630
8/15	14	9:15a	8/15/02 9:15	13.68	93.8	45.6	26.8	1020	0.0848
8/15	14	5:45p	8/15/02 17:45	14.04	95.6	28.6	39.1	1010	0.0532
8/16	15	7:55a	8/16/02 7:55	14.63	95.6	11	62.8	1000	0.0204
8/16	15	5:05p	8/16/02 17:05	15.01	95.6	6.14	77.2	995	0.0114
8/17	16	10:30a	8/17/02 10:30	15.74	95.1	2.51	98.6	999	0.0047
8/17	16	5:30p	8/17/02 17:30	16.03	95.1	2.13	102.6	995	0.0040
8/18	17	9:15a	8/18/02 9:15	16.68	95.1	1.66	108.8	925	0.0031
8/18	17	5:50p	8/18/02 17:50	17.04	93.3	1.58	109.6	915	0.0029
8/19	18	10:10a	8/19/02 10:10	17.72	93.3	1.31	114.2	905	0.0024
8/19	18	5:45p	8/19/02 17:45	18.04	93.3	1.24	115.5	884	0.0023
8/20	19	9:25a	8/20/02 9:25	18.69	93.3	0.796	126.1	832	0.0015
8/21	20	8:45a	8/21/02 8:45	19.66	96.6	0.888	124.7	1180	0.0017
8/22	21	9:45a	8/22/02 9:45	20.70	96.6	0.913	124	1220	0.0017
8/23	22	8:40a	8/23/02 8:40	21.66	96.6	0.923	123.7	1230	0.0017

Table B-6. Test 2 Outlet Data. I) Column 9 (Continued)

Column # 9 Outlet				Location (cm)	187.9	EC (uS/cm)	1750	Br- (mg/L)	538
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	8/1/02 16:15	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
8/2	1	9:10a	8/2/02 9:10	0.70	96.6	0.7	134.7	1040	0.0013
8/3	2	10:10a	8/3/02 10:10	1.75	96.6	0.926	127.7	1060	0.0017
8/4	3	3:00p	8/4/02 15:00	2.95	93.6	0.939	126.9	992	0.0017
8/5	4	6:35a	8/5/02 6:35	3.60	93.6	0.937	126.7	1020	0.0017
8/6	5	6:05a	8/6/02 6:05	4.58	93.6	1.07	124.3	971	0.0020
8/7	6	6:35a	8/7/02 6:35	5.60	93.6	1.25	120.5	1030	0.0023
8/7	6	6:00p	8/7/02 18:00	6.07	93.3	0.943	123.3	1070	0.0018
8/8	7	6:15a	8/8/02 6:15	6.58	93.3	0.994	122	1030	0.0018
8/8	7	5:50p	8/8/02 17:50	7.07	94.6	1.07	122.9	1070	0.0020
8/9	8	6:40a	8/9/02 6:40	7.60	94.6	1.09	122.5	1060	0.0020
8/9	8	6:15p	8/9/02 18:15	8.08	94.4	1.97	106.5	1020	0.0037
8/10	9	6:10a	8/10/02 6:10	8.58	94.4	4.99	83.6	940	0.0093
8/10	9	3:40p	8/10/02 15:40	8.98	94.4	11.7	62.7	1010	0.0217
8/11	10	9:00a	8/11/02 9:00	9.70	94.4	36.3	35.1	1010	0.0675
8/11	10	6:35p	8/11/02 18:35	10.10	93.9	51.4	24.5	1120	0.0955
8/12	11	8:30a	8/12/02 8:30	10.68	93.9	69.9	17.1	1160	0.1299
8/12	11	4:20p	8/12/02 16:20	11.00	94.1	83.8	12.7	1130	0.1558
8/13	12	8:10a	8/13/02 8:10	11.66	94.1	99.1	8.6	1170	0.1842
8/13	12	5:30p	8/13/02 17:30	12.05	92.4	98.7	7.8	1200	0.1835
8/14	13	9:10a	8/14/02 9:10	12.70	92.4	99.6	7.6	1190	0.1851
8/14	13	3:50p	8/14/02 15:50	12.98	93.8	96.4	8.5	1040	0.1792
8/15	14	9:20a	8/15/02 9:20	13.71	93.8	89.4	10.7	1020	0.1662
8/15	14	5:45p	8/15/02 17:45	14.06	95.6	82.4	12.9	1030	0.1532
8/16	15	8:00a	8/16/02 8:00	14.66	95.6	60.3	20.6	1030	0.1121
8/16	15	5:10p	8/16/02 17:10	15.04	95.6	44.9	27.9	1010	0.0835
8/17	16	10:25a	8/17/02 10:25	15.76	95.1	17.2	51.3	1010	0.0320
8/17	16	5:40p	8/17/02 17:40	16.06	95.1	11.3	61.8	994	0.0210
8/18	17	9:20a	8/18/02 9:20	16.71	95.1	4.19	86.1	945	0.0078
8/18	17	5:55p	8/18/02 17:55	17.07	93.3	2.16	102.1	889	0.0040
8/19	18	10:10a	8/19/02 10:10	17.75	93.3	1.29	114.6	884	0.0024
8/19	18	5:50p	8/19/02 17:50	18.07	93.3	1.11	118.1	904	0.0021
8/20	19	9:25a	8/20/02 9:25	18.72	93.3	0.963	121.5	855	0.0018
8/21	20	8:50a	8/21/02 8:50	19.69	96.6	0.943	123.3	1140	0.0018
8/22	21	9:45a	8/22/02 9:45	20.73	96.6	0.905	124.2	1210	0.0017
8/23	22	8:45a	8/23/02 8:45	21.69	96.6	0.899	124.4	1200	0.0017

Table B-7. Test 2 Outlet CXTFIT Data. A) Column 1 (2 pages)

```
*******************************************************************
*                                    *
*  CXTFIT VERSION 2.1 (4/17/99)                     *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE              *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                  *
*                                    *
*  Comment                                 *
*  Comment                                 *
*                                    *
*  DATA INPUT FILE: outletin.in                   *
*                                    *
*******************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
FLUX-AVERAGED CONCENTRATION
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V.......	.1500E+02	Y
D.......	.1830E+01	Y
R.......	.1000E+01	N
mu......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 1.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.6276E+00	.150E+02	.183E+01
1	.3587E+00	.150E+02	.567E+01
2	.1663E+00	.151E+02	.137E+02
3	.5145E-01	.155E+02	.283E+02
4	.9938E-02	.161E+02	.448E+02
5	.5773E-02	.166E+02	.489E+02
6	.5751E-02	.166E+02	.487E+02
7	.5751E-02	.166E+02	.487E+02
8	.5751E-02	.166E+02	.487E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.121	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .96221083
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .1743E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.1660E+02	.1046E+00	.1586E+03	.1639E+02	.1681E+02
D....	.4872E+02	.2868E+01	.1699E+02	.4288E+02	.5456E+02

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	193.6	0.74	0.0015	0	0.0015
2	193.6	1.78	0.0014	0	0.0014
3	193.6	2.99	0.0018	0	0.0018
4	193.6	3.63	0.0019	0	0.0019
5	193.6	4.61	0.0021	0	0.0021
6	193.6	5.63	0.0021	0	0.0021
7	193.6	6.11	0.0021	0.0001	0.002
8	193.6	6.62	0.002	0.0006	0.0014
9	193.6	7.1	0.0022	0.0024	-0.0003
10	193.6	7.64	0.0036	0.0082	-0.0047
11	193.6	8.12	0.008	0.0195	-0.0115
12	193.6	8.61	0.0223	0.0392	-0.0169
13	193.6	9.01	0.0448	0.0618	-0.017
14	193.6	9.73	0.1093	0.1127	-0.0034
15	193.6	10.14	0.1271	0.1426	-0.0154
16	193.6	10.72	0.1626	0.1776	-0.015
17	193.6	11.05	0.1719	0.1912	-0.0193
18	193.6	11.7	0.1877	0.201	-0.0133
19	193.6	12.09	0.1751	0.1963	-0.0212
20	193.6	12.74	0.1664	0.1748	-0.0084
21	193.6	13.02	0.1519	0.1619	-0.01
22	193.6	13.75	0.1281	0.1241	0.004
23	193.6	14.1	0.1033	0.1059	-0.0026
24	193.6	14.69	0.0582	0.078	-0.0198
25	193.6	15.08	0.0338	0.0622	-0.0284
26	193.6	15.78	0.0086	0.0396	-0.031
27	193.6	16.09	0.0054	0.0319	-0.0265
28	193.6	16.75	0.003	0.0195	-0.0165
29	193.6	17.1076	0.0029	0.0147	-0.0119
30	193.6	17.7847	0.0024	0.0084	-0.006
31	193.6	18.1007	0.0022	0.0064	-0.0042
32	193.6	18.7535	0.0021	0.0036	-0.0015
33	193.6	19.7257	0.002	0.0014	0.0006
34	193.6	20.7674	0.002	0.0005	0.0015
35	193.6	21.7257	0.0018	0.0002	0.0016

(Table continued on next page)

Table B-7. Test 2 Outlet CXTFIT Data. B) Column 2 (2 pages) (Continued)

```
$
*********************************************************************
*                                            *
*  CXTFIT VERSION 2.1 (4/17/99)                           *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                     *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                      *
*                                            *
*  Comment                                          *
*  Comment                                          *
*                                            *
*  DATA INPUT FILE: outletin.in                             *
*                                            *
*********************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V.......   .1500E+02    Y
D.......   .1830E+01    Y
R.......   .1000E+01    N
mu......   .0000E+00    N


BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
  SINGLE PULSE OF CONC. =   1.0000 & DURATION =   1.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM


PARAMETER ESTIMATION MODE
=========================
  MAXIMUM NUMBER OF ITERATIONS =  50


ITER   SSQ      V....   D....
 0  .6106E+00  .150E+02  .183E+01
 1  .2985E+00  .150E+02  .595E+01
 2  .1142E+00  .151E+02  .144E+02
 3  .2885E-01  .152E+02  .293E+02
 4  .6944E-02  .156E+02  .446E+02
 5  .5441E-02  .158E+02  .490E+02
 6  .5435E-02  .158E+02  .490E+02
 7  .5435E-02  .158E+02  .490E+02


COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....  D....
  V....  1.000
  D....  -.133  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .96037496
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .1647E-03


NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                        95% CONFIDENCE LIMITS
NAME    VALUE    S.E.COEFF. T-VALUE    LOWER     UPPER
V....  .1584E+02  .1033E+00 .1534E+03  .1563E+02  .1605E+02
D....  .4905E+02  .2907E+01 .1687E+02  .4313E+02  .5496E+02
```

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	192.1	0.7569	0.0014	0	0.0014
2	192.1	1.7986	0.0014	0	0.0014
3	192.1	3	0.002	0	0.002
4	192.1	3.6493	0.0019	0	0.0019
5	192.1	4.6319	0.002	0	0.002
6	192.1	5.6493	0.0021	0	0.0021
7	192.1	6.125	0.0018	0.0001	0.0017
8	192.1	6.6354	0.002	0.0004	0.0016
9	192.1	7.1215	0.0025	0.0017	0.0008
10	192.1	7.6563	0.0025	0.0057	-0.0031
11	192.1	8.1354	0.0037	0.0137	-0.01
12	192.1	8.6319	0.0095	0.0285	-0.019
13	192.1	9.0278	0.0223	0.0458	-0.0235
14	192.1	9.75	0.0751	0.088	-0.0129
15	192.1	10.1493	0.1007	0.1141	-0.0134
16	192.1	10.7326	0.1411	0.1497	-0.0086
17	192.1	11.059	0.1643	0.1658	-0.0015
18	192.1	11.7153	0.1775	0.1855	-0.0079
19	192.1	12.1042	0.1649	0.1881	-0.0233
20	192.1	12.7569	0.1569	0.1787	-0.0218
21	192.1	13.0313	0.1515	0.1705	-0.0191
22	192.1	13.7639	0.1338	0.1411	-0.0073
23	192.1	14.1181	0.1225	0.125	-0.0025
24	192.1	14.7083	0.0991	0.0982	0.0009
25	192.1	15.0903	0.0745	0.082	-0.0075
26	192.1	15.8056	0.0314	0.0561	-0.0247
27	192.1	16.1042	0.0216	0.0471	-0.0256
28	192.1	16.7639	0.0085	0.0312	-0.0227
29	192.1	17.1215	0.0056	0.0245	-0.019
30	192.1	17.7986	0.0029	0.0152	-0.0122
31	192.1	18.1146	0.0025	0.012	-0.0095
32	192.1	18.7708	0.0021	0.0072	-0.0051
33	192.1	19.7431	0.0019	0.0033	-0.0014
34	192.1	20.7847	0.0018	0.0013	0.0005
35	192.1	21.7396	0.0018	0.0006	0.0013

Table B-7. Test 2 Outlet CXTFIT Data. C) Column 3 (2 pages) (Continued)

```
*********************************************************************
*                                                                   *
*  CXTFIT VERSION 2.1 (4/17/99)                                     *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                     *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                                *
*                                                                   *
*  Comment                                                          *
*  Comment                                                          *
*                                                                   *
*  DATA INPUT FILE: outletin.in                                     *
*                                                                   *
*********************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
 V.......   .1500E+02      Y
 D.......   .1830E+01      Y
 R.......   .1000E+01      N
 mu......   .0000E+00      N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =   1.0000 & DURATION =   1.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER    SSQ       V.....    D.....
 0  .4493E+00  .150E+02  .183E+01
 1  .2226E+00  .150E+02  .540E+01
 2  .8587E-01  .151E+02  .118E+02
 3  .2688E-01  .154E+02  .203E+02
 4  .1473E-01  .157E+02  .263E+02
 5  .1406E-01  .157E+02  .280E+02
 6  .1404E-01  .158E+02  .284E+02
 7  .1404E-01  .158E+02  .285E+02
 8  .1404E-01  .158E+02  .285E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....  D....
 V....  1.000
 D....  -.132  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .92263714
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .4256E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                                       95% CONFIDENCE LIMITS
NAME     VALUE    S.E.COEFF.  T-VALUE    LOWER      UPPER
V....  .1575E+02  .1110E+00  .1419E+03  .1553E+02  .1598E+02
D....  .2846E+02  .2429E+01  .1172E+02  .2352E+02  .3340E+02
```

----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	193.5	0.7361	0.0013	0	0.0013
2	193.5	1.7778	0.0014	0	0.0014
3	193.5	2.9826	0.0019	0	0.0019
4	193.5	3.6285	0.0019	0	0.0019
5	193.5	4.6111	0.0019	0	0.0019
6	193.5	5.6285	0.0021	0	0.0021
7	193.5	6.1076	0.002	0	0.002
8	193.5	6.6181	0.002	0	0.002
9	193.5	7.1042	0.0025	0	0.0025
10	193.5	7.6354	0.0025	0.0003	0.0022
11	193.5	8.1181	0.0024	0.0014	0.001
12	193.5	8.6146	0.0025	0.0052	-0.0026
13	193.5	9.0139	0.0038	0.0125	-0.0087
14	193.5	9.7326	0.0232	0.0429	-0.0197
15	193.5	10.1354	0.0463	0.0721	-0.0258
16	193.5	10.7153	0.0981	0.1261	-0.028
17	193.5	11.0417	0.1401	0.1587	-0.0185
18	193.5	11.6979	0.1877	0.2138	0.0261
19	193.5	12.0903	0.1952	0.2331	-0.0379
20	193.5	12.7396	0.2063	0.2355	-0.0292
21	193.5	13.0174	0.2063	0.2261	-0.0198
22	193.5	13.7465	0.1896	0.1814	0.0081
23	193.5	14.1007	0.15	0.1545	-0.0045
24	193.5	14.691	0.0665	0.1104	-0.0438
25	193.5	15.0729	0.0305	0.0852	-0.0547
26	193.5	15.7778	0.0061	0.0488	-0.0427
27	193.5	16.0764	0.004	0.0375	-0.0335
28	193.5	16.7465	0.0029	0.0197	-0.0169
29	193.5	17.1042	0.0026	0.0136	-0.011
30	193.5	17.7813	0.0025	0.0064	-0.0039
31	193.5	18.1007	0.0025	0.0044	-0.002
32	193.5	18.75	0.0023	0.002	0.0003
33	193.5	19.7257	0.0019	0.0006	0.0013
34	193.5	20.7604	0.0018	0.0001	0.0017
35	193.5	21.7222	0.0019	0	0.0018

Table B-7. Test 2 Outlet CXTFIT Data. D) Column 4 (2 pages) (Continued)

$

```
*******************************************************************
*                                              *
*   CXTFIT VERSION 2.1 (4/17/99)                          *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                   *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                          *
*                                              *
*   Comment                                        *
*   Comment                                        *
*                                              *
*   DATA INPUT FILE:  outletin.in                       *
*                                              *
*******************************************************************


MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


INITIAL VALUES OF COEFFICIENTS
==============================
NAME     INITIAL VALUE  FITTING
 V.......   .1500E+02     Y
 D.......   .1830E+01     Y
 R.......   .1000E+01     N
 mu......   .0000E+00     N


BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =   1.0000 & DURATION =   1.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM


PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50


ITER   SSQ       V....     D....
 0   .6793E+00  .150E+02  .183E+01
 1   .3249E+00  .151E+02  .614E+01
 2   .1097E+00  .154E+02  .144E+02
 3   .1895E-01  .160E+02  .261E+02
 4   .7545E-02  .164E+02  .299E+02
 5   .7423E-02  .165E+02  .292E+02
 6   .7422E-02  .165E+02  .292E+02
 7   .7422E-02  .165E+02  .291E+02


COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
       V....   D....
 V....  1.000
 D....  -.123   1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .96329553
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =   .2249E-03


NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                        95% CONFIDENCE LIMITS
NAME     VALUE    S.E.COEFF. T-VALUE   LOWER      UPPER
V....  .1649E+02  .8140E-01 .2025E+03  .1632E+02  .1665E+02
D....  .2914E+02  .1783E+01 .1634E+02  .2551E+02  .3277E+02
```

---------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	192.2	0.7396	0 0014	0	0.0014
2	192.2	1.7813	0.0014	0	0.0014
3	192.2	2.9826	0.0019	0	0.0019
4	192.2	3.6319	0.0019	0	0.0019
5	192.2	4.6111	0.002	0	0.002
6	192.2	5 6319	0.0022	0	0.0022
7	192.2	6.1076	0.0018	0	0.0018
8	192.2	6.6181	0.002	0	0.002
9	192.2	7 1007	0 0024	0.0001	0.0022
10	192.2	7 6354	0.0033	0 001	0.0023
11	192.2	8.1146	0.0073	0.0042	0 0032
12	192.2	8.6146	0 0154	0.0138	0.0016
13	192.2	9 0104	0.0266	0 0295	-0.003
14	192.2	9 7396	0.0413	0.0841	-0 0428
15	192.2	10.1319	0.1033	0.1252	-0.0219
16	192.2	10 7153	0.1695	0.1892	-0.0197
17	192.2	11 0486	0.2007	0.2198	-0.0191
18	192.2	11.6979	0 2361	0.2519	-0 0159
19	192 2	12.0868	0.2342	0.2504	-0.0162
20	192.2	12.7604	0.2045	0.2164	-0.0119
21	192.2	13.0174	0.1792	0.1965	-0.0174
22	192 2	13.7049	0.1069	0.1378	-0 031
23	192.2	14.1007	0.0805	0.106	-0.0256
24	192.2	14 6944	0.0398	0.0667	-0 0269
25	192.2	15.0764	0.0229	0.0475	-0 0246
26	192.2	15.7882	0.0077	0.0234	-0.0158
27	192.2	16.0903	0.006	0.0169	-0.0109
28	192.2	16.7431	0.0039	0.0079	-0.004
29	192.2	17.1042	0.0038	0.0051	-0 0013
30	192.2	17.7813	0.0031	0.0021	0.001
31	192.2	18.0972	0.0028	0.0014	0.0014
32	192 2	18.75	0.0024	0.0005	0.0019
33	192.2	19.7222	0.002	0.0001	0.0019
34	192 2	20.7708	0.0019	0	0.0019
35	192.2	21 7222	0.0019	0	0.0019

Table B-7. Test 2 Outlet CXTFIT Data. E) Column 5 (2 pages) (Continued)

```
*********************************************************************
*                                                                   *
*   CXTFIT VERSION 2.1 (4/17/99)                                    *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                    *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                               *
*                                                                   *
*   Comment                                                         *
*   Comment                                                         *
*                                                                   *
*   DATA INPUT FILE:  outletin.in                                   *
*                                                                   *
*********************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME       INITIAL VALUE   FITTING
V.......    .1500E+02       Y
D.......    .1830E+01       Y
R.......    .1000E+01       N
mu......    .0000E+00       N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =   1.0000 & DURATION =   1.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER    SSQ      V...     D...
 0  .3871E+00  .150E+02  .183E+01
 1  .1317E+00  .149E+02  .565E+01
 2  .2155E-01  .147E+02  .119E+02
 3  .1531E-02  .144E+02  .169E+02
 4  .9515E-03  .143E+02  .171E+02
 5  .9458E-03  .143E+02  .170E+02
 6  .9458E-03  .143E+02  .170E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V...   D...
  V...  1.000
  D...  -.125  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99616773
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .2866E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                              95% CONFIDENCE LIMITS
NAME     VALUE    S.E.COEFF.  T-VALUE    LOWER       UPPER
V...  .1427E+02  .2032E-01  .7024E+03  .1423E+02  .1431E+02
D...  .1699E+02  .3612E+00  .4704E+02  .1625E+02  .1772E+02
```

-----------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	CONCENTRATION FITTED	RESI-DUAL
1	194.2	0.7083	0.0013	0	0.0013
2	194.2	1.75	0.0014	0	0.0014
3	194.2	2.9549	0.0019	0	0.0019
4	194.2	3.6007	0.0018	0	0.0018
5	194.2	4.5833	0.0019	0	0.0019
6	194.2	5.6007	0.002	0	0.002
7	194.2	6.0799	0.0017	0	0.0017
8	194.2	6.5868	0.0018	0	0.0018
9	194.2	7.0729	0.0023	0	0.0023
10	194.2	7.6076	0.0022	0	0.0022
11	194.2	8.0868	0.0023	0	0.0023
12	194.2	8.5868	0.0023	0	0.0023
13	194.2	8.9826	0.0023	0.0001	0.0022
14	194.2	9.7014	0.0027	0.0012	0.0015
15	194.2	10.1042	0.0046	0.0039	0.0007
16	194.2	10.684	0.0051	0.0151	-0.01
17	194.2	11.0139	0.0206	0.0282	-0.0076
18	194.2	11.6667	0.0667	0.0748	-0.008
19	194.2	12.0451	0.1169	0.1139	0.003
20	194.2	12.7118	0.1914	0.1912	0.0003
21	194.2	12.9896	0.2156	0.2197	-0.0041
22	194.2	13.7188	0.2491	0.2621	-0.013
23	194.2	14.0694	0.2528	0.2612	-0.0084
24	194.2	14.6632	0.2286	0.231	-0.0023
25	194.2	15.0451	0.2045	0.1988	0.0056
26	194.2	15.7604	0.1296	0.1314	-0.0019
27	194.2	16.059	0.1017	0.1055	-0.0038
28	194.2	16.7153	0.0507	0.0596	-0.0089
29	194.2	17.0764	0.029	0.0415	-0.0125
30	194.2	17.7535	0.0108	0.0194	-0.0086
31	194.2	18.0729	0.0074	0.0131	-0.0057
32	194.2	18.7222	0.0045	0.0055	-0.0011
33	194.2	19.6944	0.0024	0.0013	0.0011
34	194.2	20.7361	0.002	0.0002	0.0018
35	194.2	21.6944	0.0019	0	0.0018

Table B-7. Test 2 Outlet CXTFIT Data. F) Column 6 (2 pages) (Continued)

```
*******************************************************************
*                                                                 *
*  CXTFIT VERSION 2.1 (4/17/99)                                   *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                   *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                              *
*                                                                 *
*  Comment                                                        *
*  Comment                                                        *
*                                                                 *
*  DATA INPUT FILE: outletin.in                                   *
*                                                                 *
*******************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE   FITTING
 V........    .1500E+02     Y
 D........    .1830E+01     Y
 R........    .1000E+01     N
 mu.......    .0000E+00     N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
  SINGLE PULSE OF CONC. =   1.0000 & DURATION =   1.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
  MAXIMUM NUMBER OF ITERATIONS =   50

ITER   SSQ       V.....   D....
 0   .5063E+00  .150E+02  .183E+01
 1   .2249E+00  .150E+02  .589E+01
 2   .6701E-01  .152E+02  .135E+02
 3   .1016E-01  .155E+02  .236E+02
 4   .2836E-02  .158E+02  .284E+02
 5   .2733E-02  .158E+02  .285E+02
 6   .2733E-02  .158E+02  .286E+02
 7   .2733E-02  .158E+02  .286E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
         V....  D....
  V....  1.000
  D.... -.132  1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .98678076
  (COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) =  .8281E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                                      95% CONFIDENCE LIMITS
NAME     VALUE    S.E.COEFF.  T-VALUE    LOWER      UPPER
V....  .1582E+02  .4911E-01  .3221E+03  .1572E+02  .1592E+02
D....  .2856E+02  .1074E+01  .2659E+02  .2637E+02  .3074E+02
```

------------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	192.8	0.7257	0.0013	0	0.0013
2	192.8	1.7674	0.0014	0	0.0014
3	192.8	2.9688	0.0018	0	0.0018
4	192.8	3.6181	0.0018	0	0.0018
5	192.8	4.5972	0.0021	0	0.0021
6	192.8	5.6181	0.0021	0	0.0021
7	192.8	6.0938	0.0018	0	0.0018
8	192.8	6.6042	0.0018	0	0.0018
9	192.8	7.0868	0.0019	0	0.0019
10	192.8	7.6215	0.0022	0.0003	0.0018
11	192.8	8.1042	0.0023	0.0016	0.0007
12	192.8	8.6007	0.0027	0.0059	-0.0032
13	192.8	8.9965	0.0058	0.014	-0.0082
14	192.8	9.7153	0.0329	0.047	-0.0141
15	192.8	10.1181	0.0626	0.0778	-0.0152
16	192.8	10.7014	0.1271	0.134	-0.0069
17	192.8	11.0278	0.1576	0.1667	-0.0091
18	192.8	11.6806	0.2193	0.2197	-0.0004
19	192.8	12.0729	0.2249	0.2367	-0.0118
20	192.8	12.7257	0.2193	0.2348	-0.0155
21	192.8	13.0035	0.2063	0.2237	-0.0173
22	192.8	13.7326	0.1664	0.1759	-0.0095
23	192.8	14.0833	0.1535	0.1487	0.0048
24	192.8	14.6771	0.105	0.1044	0.0006
25	192.8	15.059	0.0608	0.0798	-0.019
26	192.8	15.7778	0.0251	0.0445	-0.0194
27	192.8	16.0764	0.0161	0.0339	-0.0178
28	192.8	16.7292	0.0062	0.0178	-0.0116
29	192.8	17.0903	0.0045	0.0122	-0.0077
30	192.8	17.7674	0.003	0.0057	-0.0027
31	192.8	18.0833	0.0026	0.0039	-0.0013
32	192.8	18.7361	0.0024	0.0017	0.0006
33	192.8	19.7118	0.0019	0.0005	0.0014
34	192.8	20.7535	0.0018	0.0001	0.0017
35	192.8	21.7083	0.0016	0	0.0016

Table B-7. Test 2 Outlet CXTFIT Data. G) Column 7 (2 pages) (Continued)

```
*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: outletin.in                                 *
*                                                               *
*****************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE   FITTING
V.......  .1500E+02       Y
D.......  .1830E+01       Y
R.......  .1000E+01       N
mu......  .0000E+00       N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
  SINGLE PULSE OF CONC. =  1.0000 & DURATION =  1.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
  MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ        V.....    D.....
 0   .5052E+00  .150E+02  .183E+01
 1   .2165E+00  .151E+02  .576E+01
 2   .6018E-01  .154E+02  .123E+02
 3   .9158E-02  .158E+02  .194E+02
 4   .4678E-02  .160E+02  .214E+02
 5   .4652E-02  .160E+02  .215E+02
 6   .4652E-02  .160E+02  .215E+02
 7   .4652E-02  .160E+02  .215E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V...   D...
 V....  1.000
 D....  -.134  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .98093514
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .1410E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                              95% CONFIDENCE LIMITS
NAME    VALUE     S.E.COEFF.  T-VALUE    LOWER      UPPER
V....  .1601E+02  .5220E-01  3067E+03  .1590E+02  .1612E+02
D....  .2151E+02  .9872E+00  .2178E+02  .1950E+02  .2351E+02
```

------------------ORDERED BY COMPUTER INPUT------------------

$

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	191.2	0.69	0.0014	0	0.0014
2	191.2	1.73	0.0014	0	0.0014
3	191.2	2.93	0.0018	0	0.0018
4	191.2	3.58	0.0018	0	0.0018
5	191.2	4.56	0.002	0	0.002
6	191.2	5.58	0.0022	0	0.0022
7	191.2	7.06	0.0017	0	0.0017
8	191.2	8.07	0.0017	0.0005	0.0012
9	191.2	7.05	0.002	0	0.002
10	191.2	7.58	0.0022	0.0001	0.0022
11	191.2	8.06	0.0025	0.0005	0.002
12	191.2	8.56	0.0026	0.0028	-0.0001
13	191.2	8.96	0.0042	0.0084	-0.0042
14	191.2	9.68	0.0243	0.0388	-0.0144
15	191.2	10.08	0.053	0.0727	-0.0198
16	191.2	10.66	0.1271	0.1425	-0.0154
17	191.2	10.99	0.1727	0.1867	-0.014
18	191.2	11.64	0.2416	0.2579	-0.0163
19	191.2	12.03	0.2546	0.2781	-0.0235
20	191.2	12.69	0.2509	0.2648	-0.0138
21	191.2	12.97	0.2342	0.2441	-0.0099
22	191.2	13.69	0.1623	0.1712	-0.0089
23	191.2	14.05	0.119	0.1335	-0.0145
24	191.2	14.64	0.0509	0.0811	-0.0301
25	191.2	15.02	0.0268	0.0557	-0.0289
26	191.2	15.74	0.0079	0.0246	-0.0167
27	191.2	16.04	0.0058	0.0169	-0.011
28	191.2	16.69	0.0038	0.007	-0.0032
29	191.2	17.0521	0.0035	0.0041	-0.0006
30	191.2	17.7292	0.003	0.0014	0.0016
31	191.2	18.0486	0.0027	0.0008	0.0019
32	191.2	18.6979	0.0024	0.0003	0.0021
33	191.2	19.6736	0.0016	0	0.0016
34	191.2	20.7118	0.0016	0	0.0016
35	191.2	21.6701	0.0016	0	0.0016

Table B-7. Test 2 Outlet CXTFIT Data. H) Column 8 (2 pages) (Continued)

```
*****************************************************************
*                                            *
*  CXTFIT VERSION 2.1 (4/17/99)                       *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE             *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                   *
*                                            *
*  Comment                                      *
*  Comment                                      *
*                                            *
*  DATA INPUT FILE: outletin.in                      *
*                                            *
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MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
FLUX-AVERAGED CONCENTRATION
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V.......	.1500E+02	Y
D.......	.1830E+01	Y
R.......	.1000E+01	N
mu......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 1.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.7027E+00	.150E+02	.183E+01
1	.3432E+00	.151E+02	.604E+01
2	.1192E+00	.154E+02	.142E+02
3	.2833E-01	.160E+02	.259E+02
4	.1904E-01	.165E+02	.293E+02
5	.1894E-01	.165E+02	.285E+02
6	.1893E-01	.165E+02	.283E+02
7	.1893E-01	.165E+02	.282E+02
8	.1893E-01	.165E+02	.282E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.119	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .89820952
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .5737E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.1650E+02	.1272E+00	.1297E+03	.1624E+02	.1676E+02
D....	.2821E+02	.2736E+01	.1031E+02	.2265E+02	.3378E+02

-----------------ORDERED BY COMPUTER INPUT-----------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESIDUAL
1	190.4	0.6771	0.0013	0	0.0013
2	190.4	1.7188	0.0014	0	0.0014
3	190.4	2.8819	0.0018	0	0.0018
4	190.4	3.5694	0.0018	0	0.0018
5	190.4	4.5486	0.0022	0	0.0022
6	190.4	5.5694	0.0022	0	0.0022
7	190.4	6.0486	0.002	0	0.002
8	190.4	6.5556	0.002	0	0.0019
9	190.4	7.0417	0.0023	0.0001	0.0022
10	190.4	7.5729	0.0022	0.0009	0.0013
11	190.4	8.0556	0.0025	0.0041	-0.0016
12	190.4	8.559	0.0033	0.0139	-0.0106
13	190.4	8.9514	0.0067	0.0299	-0.0232
14	190.4	9.6701	0.037	0.0856	-0.0486
15	190.4	10.0729	0.076	0.1297	-0.0536
16	190.4	10.6528	0.1602	0.1956	-0.0354
17	190.4	10.9792	0.2026	0.2263	-0.0237
18	190.4	11.6354	0.2398	0.2578	-0.018
19	190.4	12.0278	0.2268	0.2542	-0.0274
20	190.4	12.691	0.1758	0.2165	-0.0407
21	190.4	12.9583	0.163	0.1944	-0.0313
22	190.4	13.684	0.0848	0.1297	-0.045
23	190.4	14.0382	0.0532	0.101	-0.0478
24	190.4	14.6285	0.0204	0.0621	-0.0417
25	190.4	15.0104	0.0114	0.0435	-0.0321
26	190.4	15.7361	0.0047	0.0204	-0.0158
27	190.4	16.0278	0.004	0.0147	-0.0107
28	190.4	16.684	0.0031	0.0066	-0.0035
29	190.4	17.0417	0.0029	0.0042	-0.0012
30	190.4	17.7222	0.0024	0.0017	0.0008
31	190.4	18.0382	0.0023	0.0011	0.0012
32	190.4	18.691	0.0015	0.0004	0.0011
33	190.4	19.6632	0.0017	0.0001	0.0016
34	190.4	20.7049	0.0017	0	0.0017
35	190.4	21.6597	0.0017	0	0.0017

Table B-7. Test 2 Outlet CXTFIT Data. I) Column 9 (2 pages) (Continued)

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*****************************************************************
*                                             *
*  CXTFIT VERSION 2.1 (4/17/99)                      *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE             *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                  *
*                                             *
*  Comment                                    *
*  Comment                                    *
*                                             *
*  DATA INPUT FILE: outletin in                    *
*                                             *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
FLUX-AVERAGED CONCENTRATION
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.1500E+02	Y
D........	.1830E+01	Y
R........	.1000E+01	N
mu........	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 1.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V...	D...
0	.6307E+00	.150E+02	.183E+01
1	.2650E+00	.150E+02	.530E+01
2	.8870E-01	.150E+02	.122E+02
3	.1963E-01	.151E+02	.237E+02
4	.4897E-02	.152E+02	.342E+02
5	.3665E-02	.154E+02	.378E+02
6	.3643E-02	.154E+02	.383E+02
7	.3643E-02	.154E+02	.384E+02
8	.3643E-02	.154E+02	.384E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V...	D....
V....	1.000	
D....	-.133	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .97811092
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .1104E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

NAME	VALUE	S.E.COEFF.	T-VALUE	95% CONFIDENCE LIMITS LOWER	UPPER
V....	.1538E+02	.7131E-01	.2157E+03	.1523E+02	.1552E+02
D....	.3838E+02	.1798E+01	.2135E+02	.3472E+02	.4204E+02

-----------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	187.9	0.7049	0.0013	0	0.0013
2	187.9	1.7465	0.0017	0	0.0017
3	187.9	2.9479	0.0017	0	0.0017
4	187.9	3.5972	0.0017	0	0.0017
5	187.9	4.5764	0.002	0	0.002
6	187.9	5.5972	0.0023	0	0.0023
7	187.9	6.0729	0.0018	0	0.0017
8	187.9	6.5833	0.0018	0.0001	0.0018
9	187.9	7.066	0.002	0.0004	0.0016
10	187.9	7.6007	0.002	0.002	0.0001
11	187.9	8.0833	0.0037	0.0061	-0.0024
12	187.9	8.5799	0.0093	0.0156	-0.0063
13	187.9	8.9757	0.0217	0.0288	-0.0071
14	187.9	9.6979	0.0675	0.0678	-0.0003
15	187.9	10.0972	0.0955	0.096	-0.0005
16	187.9	10.6771	0.1299	0.1394	-0.0095
17	187.9	11.0035	0.1558	0.1617	-0.006
18	187.9	11.6632	0.1842	0.1943	-0.0101
19	187.9	12.0521	0.1835	0.2029	-0.0195
20	187.9	12.7049	0.1851	0.1988	-0.0136
21	187.9	12.9826	0.1792	0.1908	-0.0116
22	187.9	13.7118	0.1662	0.1583	0.0079
23	187.9	14.0625	0.1532	0.1395	0.0137
24	187.9	14.6563	0.1121	0.1072	0.0049
25	187.9	15.0382	0.0835	0.0879	-0.0044
26	187.9	15.7569	0.032	0.0573	-0.0253
27	187.9	16.059	0.021	0.0469	-0.0259
28	187.9	16.7118	0.0078	0.0294	-0.0216
29	187.9	17.0694	0.004	0.0223	-0.0183
30	187.9	17.7465	0.0024	0.0128	-0.0104
31	187.9	18.066	0.0021	0.0097	-0.0077
32	187.9	18.7153	0.0018	0.0054	-0.0036
33	187.9	19.691	0.0018	0.0021	-0.0004
34	187.9	20.7292	0.0017	0.0007	0.0009
35	187.9	21.6875	0.0017	0.0003	0.0014

Appendix C. Third Bromide Tracer Test

Table C-1. Test 3 Tracer Application Data.

Column	1/14/03 Begin Pulse	1/15/03 End Pulse
1	5:43 PM	6:10 PM
2	4:45 PM	5:55 PM
3	5:48 PM	7:10 PM
4	7:00 PM	7:00 PM
5	6:10 PM	6:05 PM
6	6:25 PM	6:00 PM
7	6:38 PM	6:02 PM
8	6:15 PM	7:10 PM
9	5:55 PM	5:50 PM

Table C-2. Test 3 ΔW Values for Effluent Velocity Calculations.

Time	Water Weights (values in g)									
	1	2	3	4	5	6	7	8	9	
1/13/03 14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(empty bottles)
1/14/03 16:35	507.3	612.9	574.4	611.2	588.7	600.0	680.6	616.2	637.0	
1/15/03 11:10	489.1	372.2	275.0	385.0	341.9	305.5	423.6	351.5	385.7	
1/16/03 11:30	604.5	470.5	376.2	307.6	463.2	50.5	554.4	468.1	497.1	
1/17/03 17:51	580.8	616.0	610.4	236.0	602.7	697.5	705.3	657.8	616.8	
1/18/03 10:40	381.3	381.9	382.7	396.1	378.0	474.1	434.8	400.3	295.9	
1/19/03 13:10	449.1	549.6	481.0	564.6	541.8	665.8	615.6	577.6	604.0	
1/20/03 14:20	534.4	546.6	549.2	561.5	542.9	664.6	600.4	574.2	695.4	
1/21/03 14:20	402.6	525.1	548.6	560.5	545.8	665.3	622.2	569.0	452.6	
1/22/03 11:50	572.5	387.4	437.8	470.5	445.5	544.4	507.1	470.5	575.0	
1/23/03 10:45	571.0	414.4	477.0	510.8	475.6	582.6	548.1	506.0	415.7	
1/24/03 14:55	578.9	517.9	598.9	633.4	592.3	728.1	681.9	633.2	660.7	
1/25/03 11:00	476.6	352.6	405.5	428.1	392.0	508.8	455.7	425.5	325.8	
1/26/03 13:35	436.0	465.0	467.5	513.8	511.4	639.9	593.0	549.4	352.5	
1/27/03 15:30	642.8	507.7	503.3	583.2	562.3	690.4	641.3	567.4	750.1	
1/28/03 14:25	390.2	416.3	453.0	491.3	461.9	591.0	541.1	446.3	374.7	
1/29/03 11:35	564.9	394.7	386.6	469.6	433.8	532.0	506.6	469.2	645.0	
1/30/03 11:50	426.5	464.2	492.4	521.6	494.3	624.2	568.6	460.2	496.4	
1/31/03 12:10	672.7	431.6	463.5	530.1	495.4	608.7	568.4	573.8	573.6	
2/1/03 12:00	475.2	400.4	436.1	487.8	423.6	570.0	462.9	395.6	395.4	
2/2/03 10:10	547.3	420.2	401.1	483.5	455.9	531.5	505.0	516.8	516.6	
2/3/03 11:35	503.1	459.0	488.3	430.5	401.1	615.3	558.2	395.8	395.6	
2/4/03 16:14	498.0	505.0	539.4	550.0	548.9	560.7	595.0	603.2	603.0	
2/5/03 7:50	307.8	285.7	3.0	313.6	291.9	311.2	327.0	289.4	289.2	
2/6/03 11:30	639.4	486.5	510.4	618.8	458.4	733.4	568.1	569.1	568.9	
2/7/03 18:10	596.1	517.1	561.0	721.4	534.1	684.9	612.4	599.4	599.2	
2/8/03 19:05	497.6	412.2	469.0	589.8	378.4	354.8	476.9	282.9	282.7	
2/10/03 11:50	861.3	677.7	788.7	991.7	805.2	1010.5	861.6	938.9	938.7	
2/11/03 12:05	536.8	435.6	498.8	611.9	505.5	615.2	574.0	540.5	540.3	
2/12/03 12:05	537.6	450.7	492.4	610.2	508.8	605.1	551.3	535.4	535.2	
2/13/03 11:25	539.7	452.1	494.5	609.7	509.4	608.3	548.7	576.4	576.2	
2/14/03 11:40	543.5	460.5	505.0	617.5	506.7	606.5	555.3	550.3	550.1	
2/15/03 15:35	600.1	500.0	521.6	666.9	441.0	639.6	610.8	574.1	573.9	
2/16/03 13:10	395.2	381.7	433.1	554.3	465.4	539.1	471.1	500.5	500.3	
2/17/03 10:50	428.5	411.2	468.3	552.5	490.8	582.2	506.4	295.9	295.7	
Sums	17788.0	15682.4	16093.7	18185.0	16594.3	19741.6	19033.3	17480.3	17514.7	
Bulk avg v (cm/day)	8.00	7.05	7.24	8.18	7.46	8.88	8.56	7.86	7.88	
Total time (day)	34.84									

$v = \Delta W / A n t \rho$

n 0.35 A (cm^2) 182.4

Table C-3. Test 3 Daily Effluent Velocity Values.

Date	Day Fraction	Rate (cm/day) (0.405 mL/min equals 9.144 cm/day)								
		1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1
1/13/03 14:45										
1/14/03 16:35	1.08	7.383	8.919	8.359	8.895	8.567	8.732	9.905	8.967	9.270
1/15/03 11:10	0.77	9.895	7.529	5.563	7.789	6.917	6.179	8.569	7.110	7.802
1/16/03 11:30	1.01	9.339	7.269	5.812	4.752	7.156	0.780	8.565	7.232	7.680
1/17/03 17:51	1.26	7.194	7.631	7.561	2.923	7.465	8.640	8.736	8.149	7.640
1/18/03 10:40	0.70	8.525	8.537	8.555	8.854	8.450	10.598	9.720	8.948	6.615
1/19/03 13:10	1.10	6.371	7.797	6.824	8.010	7.685	9.446	8.734	8.194	8.568
1/20/03 14:20	1.05	7.982	8.166	8.204	8.388	8.110	9.928	8.969	8.578	10.387
1/21/03 14:20	1.00	6.306	8.225	8.593	8.780	8.549	10.422	9.746	8.913	7.089
1/22/03 11:50	0.90	10.010	6.774	7.655	8.228	7.790	9.518	8.867	8.227	10.054
1/23/03 10:45	0.95	9.366	6.798	7.825	8.380	7.801	9.557	8.991	8.301	6.820
1/24/03 14:55	1.17	7.726	6.912	7.994	8.454	7.905	9.718	9.101	8.451	8.819
1/25/03 11:00	0.84	8.921	6.601	7.590	8.013	7.337	9.525	8.530	7.965	6.098
1/26/03 13:35	1.11	6.165	6.577	6.611	7.266	7.231	9.050	8.387	7.769	4.984
1/27/03 15:30	1.08	9.324	7.365	7.301	8.460	8.157	10.015	9.303	8.231	10.881
1/28/03 14:25	0.95	6.400	6.829	7.431	8.060	7.577	9.695	8.877	7.321	6.147
1/29/03 11:35	0.88	10.033	7.011	6.866	8.341	7.705	9.448	8.997	8.334	11.455
1/30/03 11:50	1.01	6.612	7.197	7.633	8.087	7.663	9.676	8.815	7.134	7.695
1/31/03 12:10	1.01	10.393	6.668	7.160	8.189	7.654	9.404	8.781	8.864	8.861
2/1/03 12:00	0.99	7.496	6.316	6.879	7.695	6.682	8.991	7.302	6.241	6.238
2/2/03 10:10	0.92	9.282	7.126	6.803	8.199	7.732	9.014	8.564	8.765	8.761
2/3/03 11:35	1.06	7.442	6.789	7.222	6.367	5.933	9.101	8.256	5.854	5.851
2/4/03 16:14	1.19	6.534	6.627	7.078	7.217	7.203	7.357	7.807	7.915	7.913
2/5/03 7:50	0.65	7.417	6.885	0.073	7.558	7.034	7.500	7.880	6.973	6.969
2/6/03 11:30	1.15	8.689	6.611	6.935	8.408	6.228	9.965	7.719	7.732	7.730
2/7/03 18:10	1.28	7.308	6.339	6.878	8.844	6.548	8.396	7.508	7.348	7.346
2/8/03 19:05	1.04	7.507	6.219	7.076	8.899	5.709	5.353	7.195	4.269	4.266
2/10/03 11:50	1.70	7.946	6.252	7.276	9.149	7.429	9.322	7.949	8.662	8.660
2/11/03 12:05	1.01	8.322	6.752	7.733	9.487	7.836	9.538	8.899	8.379	8.375
2/12/03 12:05	1.00	8.421	7.060	7.712	9.559	7.970	9.479	8.635	8.387	8.384
2/13/03 11:25	0.97	8.696	7.284	7.967	9.823	8.207	9.800	8.841	9.287	9.284
2/14/03 11:40	1.01	8.426	7.140	7.828	9.572	7.854	9.403	8.609	8.531	8.528
2/15/03 15:35	1.16	8.081	6.733	7.024	8.981	5.938	8.614	8.225	7.731	7.728
2/16/03 13:10	0.90	6.884	6.649	7.543	9.655	8.106	9.389	8.205	8.718	8.715
2/17/03 10:50	0.90	7.435	7.135	8.126	9.586	8.515	10.102	8.787	5.133	5.130
	Daily avg v (cm/day)	8.05	7.08	7.17	8.20	7.49	8.87	8.59	7.84	7.85
	Total time (day)									
	34.84									

$v = \Delta W / Antp$

n 0.35 A (cm^2) 182.4

Table C-4. Test 3 Outlet Data. A) Column 1

Column # 1 Outlet				Location (cm)	193.6	EC (uS/cm)	1840	Br- (mg/L)	453
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	1.20	105.1	1060	0.0026
1/16	1	4:50 PM	1/16/03 16:50	0.95	95.3	0.926	113.2	888	0.0020
1/17	2	3:15 PM	1/17/03 15:15	1.89	95.3	0.928	113.1	914	0.0020
1/18	3	11:20 AM	1/18/03 11:20	2.72	95.3	0.936	112.9	921	0.0021
1/19	4	11:50 AM	1/19/03 11:50	3.74	92.2	0.992	113.0	953	0.0022
1/20	5	11:00 AM	1/20/03 11:00	4.71	92.2	0.830	117.3	909	0.0018
1/21	6	2:45 PM	1/21/03 14:45	5.86	94.1	0.628	132.0	995	0.0014
1/22	7	12:05 PM	1/22/03 12:05	6.75	94.1	0.626	136.5	1020	0.0014
1/23	8	11:10 AM	1/23/03 11:10	7.72	94.1	0.500	137.8	1030	0.0011
1/24	9	3:10 PM	1/24/03 15:10	8.88	93.4	1.08	118.5	903	0.0024
1/25	10	10:30 AM	1/25/03 10:30	9.69	93.4	0.872	123.9	914	0.0019
1/26	11	11:35 AM	1/26/03 11:35	10.73	93.9	0.947	121.5	911	0.0021
1/27	12	2:55 PM	1/27/03 14:55	11.87	93.9	0.899	122.8	900	0.0020
1/28	13	2:15 PM	1/28/03 14:15	12.84	91.4	3.62	90.8	965	0.0080
1/29	14	11:50 AM	1/29/03 11:50	13.74	91.4	7.93	72.4	951	0.0175
1/30	15	4:35 PM	1/30/03 16:35	14.94	96.1	16.9	52.6	968	0.0373
1/31	16	11:55 AM	1/31/03 11:55	15.75	96.1	26.3	41.3	1030	0.0581
1/31	16	11:35 PM	1/31/03 23:35	16.23	94.6	32.5	34.7	991	0.0717
2/1	17	10:35 AM	2/1/03 10:35	16.69	94.6	39.1	30.0	1060	0.0863
2/1	17	11:12 PM	2/1/03 23:12	17.22	94.6	45.0	26.4	987	0.0993
2/2	18	10:25 AM	2/2/03 10:25	17.68	96.3	49.5	23.6	991	0.1093
2/3	19	11:20 AM	2/3/03 11:20	18.72	96.3	56.6	20.2	1010	0.1249
2/3	19	10:52 PM	2/3/03 22:52	19.20	96.3	59.3	19.0	1030	0.1309
2/4	20	1:20 PM	2/4/03 13:20	19.81	94.3	60.4	19.1	1010	0.1333
2/4	20	10:49 PM	2/4/03 22:49	20.20	94.3	60.7	19.0	1010	0.1340
2/5	21	7:35 AM	2/5/03 7:35	20.57	94.3	63.1	18.0	990	0.1393
2/5	21	6:13 PM	2/5/03 18:13	21.01	94.3	62.0	18.5	993	0.1369
2/6	22	11:15 AM	2/6/03 11:15	21.72	94.3	55.5	21.2	977	0.1225
2/6	22	9:17 PM	2/6/03 21:17	22.14	94.4	50.5	22.3	965	0.1115
2/7	23	7:00 AM	2/7/03 7:00	22.54	94.4	49.4	22.8	993	0.1091
2/7	23	6:22 PM	2/7/03 18:22	23.02	94.4	44.5	25.4	988	0.0982
2/8	24	6:32 AM	2/8/03 6:32	23.52	93.1	41.2	28.0	990	0.0909
2/8	24	6:50 PM	2/8/03 18:50	24.03	93.1	37.5	30.3	950	0.0828
2/9	25	10:05 AM	2/9/03 10:05	24.67	93.1	29.9	35.9	921	0.0660
2/9	25	10:32 PM	2/9/03 22:32	25.19	93.1	28.3	37.2	948	0.0625
2/10	26	11:05 AM	2/10/03 11:05	25.71	93.1	20.3	45.4	916	0.0448
2/10	26	10:06 PM	2/10/03 22:06	26.17	93.1	16.5	50.6	906	0.0364
2/11	27	11:46 AM	2/11/03 11:46	26.74	93.1	11.9	58.5	901	0.0263
2/12	28	11:45 AM	2/12/03 11:45	27.74	95.6	6.06	75.6	932	0.0134
2/13	29	11:10 AM	2/13/03 11:10	28.72	95.6	3.49	89.1	903	0.0077
2/14	30	11:20 AM	2/14/03 11:20	29.72	95.6	2.08	101.9	904	0.0046
2/15	31	3:05 PM	2/15/03 15:05	30.88	96.6	1.61	110.4	910	0.0036
2/16	32	10:10 AM	2/16/03 10:10	31.67	96.6	1.26	116.5	921	0.0028
2/17	33	10:35 AM	2/17/03 10:35	32.69	96.1	1.30	116.3	942	0.0029
2/18	34	6:13 AM	2/18/03 6:13	33.51	96.1	1.10	120.4	921	0.0024

(Table continued on next page)

Table C-4. Test 3 Outlet Data. B) Column 2 (Continued)

Column # 2 Outlet — Location (cm) 192.1 — EC (uS/cm) 1790 — Br- (mg/L) 479

(Day 0=Start of Tracer Application)

Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	1.01	109.1	1060	0.0021
1/16	1	5:00 PM	1/16/03 17:00	0.96	95.3	1.04	110.4	935	0.0022
1/17	2	3:20 PM	1/17/03 15:20	1.89	95.3	1.04	110.4	940	0.0022
1/18	3	11:30 PM	1/18/03 11:30	2.73	95.3	1.04	110.3	929	0.0022
1/19	4	11:50 PM	1/19/03 11:50	3.74	92.2	0.899	115.4	942	0.0019
1/20	5	11:10 AM	1/20/03 11:10	4.72	92.2	0.865	116.2	916	0.0018
1/21	6	3:00 PM	1/21/03 15:00	5.88	94.1	0.549	135.4	1000	0.0011
1/22	7	12:15 PM	1/22/03 12:15	6.76	94.1	0.522	136.8	1010	0.0011
1/23	8	11:20 AM	1/23/03 11:20	7.72	94.1	0.510	137.3	1030	0.0011
1/24	9	3:20 PM	1/24/03 15:20	8.89	93.4	0.871	124.0	895	0.0018
1/25	10	10:40 AM	1/25/03 10:40	9.69	93.4	0.767	127.1	901	0.0016
1/26	11	11:45 AM	1/26/03 11:45	10.74	93.9	0.860	123.9	881	0.0018
1/27	12	3:05 PM	1/27/03 15:05	11.88	93.9	0.734	127.8	887	0.0015
1/28	13	2:20 PM	1/28/03 14:20	12.85	91.4	1.27	115.4	933	0.0027
1/29	14	12:00 PM	1/29/03 12:00	13.75	91.4	1.07	119.4	917	0.0022
1/30	15	4:45 PM	1/30/03 16:45	14.95	96.1	2.22	103.7	949	0.0046
1/31	16	12:05 PM	1/31/03 12:05	15.75	96.1	3.07	95.6	948	0.0064
1/31	16	11:46 PM	1/31/03 23:46	16.24	94.6	5.40	80.3	901	0.0113
2/1	17	10:40 AM	2/1/03 10:40	16.69	94.6	7.68	71.6	982	0.0160
2/1	17	11:17 PM	2/1/03 23:17	17.22	94.6	11.2	61.9	910	0.0234
2/2	18	10:35 AM	2/2/03 10:35	17.69	96.3	15.8	52.8	958	0.0330
2/3	19	11:30 AM	2/3/03 11:30	18.73	96.3	27.2	38.8	945	0.0568
2/3	19	10:59 PM	2/3/03 22:59	19.21	96.3	36.6	31.3	945	0.0764
2/4	20	1:25 PM	2/4/03 13:25	19.81	94.3	40.3	29.0	965	0.0841
2/4	20	10:52 PM	2/4/03 22:52	20.20	94.3	47.3	25.1	960	0.0987
2/5	21	7:40 AM	2/5/03 7:40	20.57	94.3	53.0	22.3	940	0.1106
2/5	21	6:21 PM	2/5/03 18:21	21.01	94.3	59.7	19.4	960	0.1246
2/6	22	11:25 AM	2/6/03 11:25	21.73	94.3	67.4	16.4	980	0.1407
2/6	22	9:20 PM	2/6/03 21:20	22.14	94.4	69.0	14.6	990	0.1441
2/7	23	7:06 AM	2/7/03 7:06	22.55	94.4	69.9	14.3	1010	0.1459
2/7	23	6:27 PM	2/7/03 18:27	23.02	94.4	70.5	14.1	1010	0.1472
2/8	24	6:36 AM	2/8/03 6:36	23.53	93.1	82.1	11.1	991	0.1714
2/8	24	7:00 PM	2/8/03 19:00	24.04	93.1	71.7	14.4	979	0.1497
2/9	25	10:20 AM	2/9/03 10:20	24.68	93.1	67.2	16.0	963	0.1403
2/9	25	10:35 PM	2/9/03 22:35	25.19	93.1	63.1	17.6	964	0.1317
2/10	26	11:10 AM	2/10/03 11:10	25.72	93.1	50.2	23.1	965	0.1048
2/10	26	10:08 PM	2/10/03 22:08	26.17	93.1	44.9	25.9	928	0.0937
2/11	27	11:53 AM	2/11/03 11:53	26.75	93.1	37.5	30.3	949	0.0783
2/12	28	11:50 AM	2/12/03 11:50	27.74	95.6	24.9	40.6	956	0.0520
2/13	29	11:20 AM	2/13/03 11:20	28.72	95.6	16.3	51.1	948	0.0340
2/14	30	11:25 AM	2/14/03 11:25	29.73	95.6	9.60	64.2	934	0.0200
2/15	31	3:15 PM	2/15/03 15:15	30.89	96.6	5.30	80.6	877	0.0111
2/16	32	10:15 AM	2/16/03 10:15	31.68	96.6	3.78	89.1	925	0.0079
2/17	33	10:45 AM	2/17/03 10:45	32.70	96.1	2.59	99.3	909	0.0054
2/18	34	6:14 AM	2/18/03 6:14	33.51	96.1	1.91	106.8	897	0.0040

Table C-4. Test 3 Outlet Data. C) Column 3 (Continued)

Column # 3 Outlet				Location (cm)	193.5	EC (uS/cm)	1810	Br- (mg/L)	518
	(Day 1=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	1	7:00 PM	1/15/03 19:00	0.04	92.9	0.923	111.3	1100	0.0018
1/16	2	4:55 PM	1/16/03 16:55	0.95	95.3	0.999	111.3	945	0.0019
1/17	3	3:15 PM	1/17/03 15:15	1.89	95.3	1.05	110.1	933	0.0020
1/18	4	11:25 AM	1/18/03 11:25	2.73	95.3	1.02	110.8	942	0.0020
1/19	5	11:40 AM	1/19/03 11:40	3.74	92.2	0.909	115.1	940	0.0018
1/20	5	11:00 AM	1/20/03 11:00	4.71	92.2	0.821	117.6	928	0.0016
1/21	6	2:50 PM	1/21/03 14:50	5.87	94.1	0.520	136.8	1020	0.0010
1/22	7	12:10 PM	1/22/03 12:10	6.76	94.1	0.511	137.2	1030	0.0010
1/23	8	11:15 AM	1/23/03 11:15	7.72	94.1	0.522	136.7	1010	0.0010
1/24	9	3:10 PM	1/24/03 15:10	8.88	93.4	0.831	125.1	888	0.0016
1/25	10	10:30 AM	1/25/03 10:30	9.69	93.4	0.764	127.2	904	0.0015
1/26	11	11:35 AM	1/26/03 11:35	10.73	93.9	0.817	125.2	907	0.0016
1/27	12	3:00 PM	1/27/03 15:00	11.88	93.9	0.716	128.4	873	0.0014
1/28	13	2:15 PM	1/28/03 14:15	12.84	91.4	0.983	121.5	912	0.0019
1/29	14	11:55 AM	1/29/03 11:55	13.75	91.4	0.860	124.6	903	0.0017
1/30	15	4:35 PM	1/30/03 16:35	14.94	96.1	1.18	119.3	969	0.0023
1/31	16	11:55 AM	1/31/03 11:55	15.75	96.1	1.18	119.3	946	0.0023
1/31	16	11:38 PM	1/31/03 23:38	16.23	94.6	2.18	102.6	918	0.0042
2/1	17	10:35 AM	2/1/03 10:35	16.69	94.6	3.16	93.5	930	0.0061
2/1	17	11:14 PM	2/1/03 23:14	17.22	94.6	6.30	76.5	918	0.0122
2/2	18	10:30 AM	2/2/03 10:30	17.69	96.3	11.7	60.4	923	0.0226
2/3	19	11:25 AM	2/3/03 23:25	19.23	96.3	29.4	36.9	943	0.0568
2/3	19	10:52 PM	2/3/03 22:52	19.20	96.3	43.0	27.2	987	0.0830
2/4	20	1:20 PM	2/4/03 13:20	19.81	94.3	55.9	21.0	1020	0.1079
2/4	20	10:50 PM	2/4/03 22:50	20.20	94.3	60.4	19.1	975	0.1166
2/5	21	7:35 AM	2/5/03 7:35	20.57	94.3	63.7	17.8	977	0.1230
2/5	21	6:15 PM	2/5/03 18:15	21.01	94.3	74.7	13.9	979	0.1442
2/6	22	11:20 AM	2/6/03 11:20	21.72	94.3	88.0	9.9	988	0.1699
2/6	22	9:20 PM	2/6/03 21:20	22.14	94.4	93.6	7.2	1040	0.1807
2/7	23	7:01 AM	2/7/03 7:01	22.54	94.4	97.8	6.1	1030	0.1888
2/7	23	6:22 PM	2/7/03 18:22	23.02	94.4	99.1	5.8	1030	0.1913
2/8	24	6:35 AM	2/8/03 6:35	23.52	93.1	99.1	6.5	1010	0.1913
2/8	24	6:50 PM	2/8/03 18:50	24.03	93.1	94.2	7.7	1010	0.1819
2/9	25	10:10 AM	2/9/03 10:10	24.67	93.1	85.2	10.2	975	0.1645
2/9	25	10:33 PM	2/9/03 22:33	25.19	93.1	76.4	12.8	997	0.1475
2/10	26	11:05 AM	2/10/03 11:05	25.71	93.1	61.1	18.3	983	0.1180
2/10	26	10:08 PM	2/10/03 22:08	26.17	93.1	50.7	22.9	971	0.0979
2/11	27	11:47 AM	2/11/03 11:47	26.74	93.1	39.9	28.9	953	0.0770
2/12	28	11:45 AM	2/12/03 11:45	27.74	95.6	21.2	44.6	951	0.0409
2/13	29	11:10 AM	2/13/03 11:10	28.72	95.6	11.1	60.5	931	0.0214
2/14	30	11:20 AM	2/14/03 11:20	29.72	95.6	5.51	77.9	935	0.0106
2/15	31	3:05 PM	2/15/03 15:05	30.88	96.6	3.25	92.9	920	0.0063
2/16	32	10:10 AM	2/16/03 10:10	31.67	96.6	2.33	101.0	909	0.0045
2/17	33	10:35 AM	2/17/03 10:35	32.69	96.1	1.88	107.3	927	0.0036
2/18	34	6:13 AM	2/18/03 6:13	33.51	96.1	1.59	111.3	902	0.0031
			Peak day avg	23.27					

Table C-4. Test 3 Outlet Data. D) Column 4 (Continued)

Column # 4 Outlet				Location (cm)	192.2	EC (uS/cm)	1810	Br- (mg/L)	515
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	0.915	111.5	1080	0.0018
1/16	1	5:00 PM	1/16/03 17:00	0.96	95.3	0.999	111.3	938	0.0019
1/17	2	3:20 PM	1/17/03 15:20	1.89	95.3	1.02	110.7	933	0.0020
1/18	3	11:30 AM	1/18/03 11:30	2.73	95.3	1.01	111.0	931	0.0020
1/19	4	11:50 AM	1/19/03 11:50	3.74	92.2	0.932	114.5	939	0.0018
1/20	5	11:10 AM	1/20/03 11:10	4.72	92.2	0.834	116.9	921	0.0016
1/21	6	3:00 PM	1/21/03 15:00	5.88	94.1	0.581	134.0	1050	0.0011
1/22	7	12:15 PM	1/22/03 12:15	6.76	94.1	0.571	134.7	1010	0.0011
1/23	8	11:20 AM	1/23/03 11:20	7.72	94.1	0.582	133.9	1030	0.0011
1/24	9	3:20 PM	1/24/03 15:20	8.89	93.4	0.773	126.9	892	0.0015
1/25	10	10:40 AM	1/25/03 10:40	9.69	93.4	0.755	127.5	897	0.0015
1/26	11	11:45 AM	1/26/03 11:45	10.74	93.9	0.805	125.5	901	0.0016
1/27	12	3:05 PM	1/27/03 15:05	11.88	93.9	0.818	125.1	883	0.0016
1/28	13	2:20 PM	1/28/03 14:20	12.85	91.4	1.43	112.6	895	0.0028
1/29	14	12:00 PM	1/29/03 12:00	13.75	91.4	2.74	97.4	934	0.0053
1/30	15	4:45 PM	1/30/03 16:45	14.95	96.1	8.09	71.6	944	0.0157
1/31	16	12:05 PM	1/31/03 12:05	15.75	96.1	15.5	54.7	960	0.0301
1/31	16	11:45 PM	1/31/03 23:45	16.24	94.6	21.4	45.4	893	0.0416
2/1	17	10:45 AM	2/1/03 10:45	16.70	94.6	28.8	37.8	995	0.0559
2/1	17	11:21 PM	2/1/03 23:21	17.22	94.6	36.7	31.6	940	0.0713
2/2	18	10:35 AM	2/2/03 10:35	17.69	96.3	46.4	25.8	958	0.0901
2/3	19	11:30 AM	2/3/03 11:30	18.73	96.3	61.5	18.1	1000	0.1194
2/3	19	10:59 PM	2/3/03 22:59	19.21	96.3	67.8	15.6	1000	0.1317
2/4	20	1:30 PM	2/4/03 13:30	19.81	94.3	75.0	13.8	980	0.1456
2/4	20	10:52 PM	2/4/03 22:52	20.20	94.3	80.0	12.2	983	0.1553
2/5	21	7:45 AM	2/5/03 7:45	20.57	94.3	80.0	12.2	965	0.1553
2/5	21	6:21 PM	2/5/03 18:21	21.01	94.3	80.9	11.9	971	0.1571
2/6	22	11:25 AM	2/6/03 11:25	21.73	94.3	74.4	14.0	978	0.1445
2/6	22	9:24 PM	2/6/03 21:24	22.14	94.4	65.0	16.1	1000	0.1262
2/7	23	7:06 AM	2/7/03 7:06	22.55	94.4	59.5	18.3	1000	0.1155
2/7	23	6:27 PM	2/7/03 18:27	23.02	94.4	50.7	22.2	957	0.0984
2/8	24	6:36 AM	2/8/03 6:36	23.53	93.1	42.4	27.3	962	0.0823
2/8	24	7:00 PM	2/8/03 19:00	24.04	93.1	35.1	31.9	949	0.0682
2/9	25	10:20 AM	2/9/03 10:20	24.68	93.1	24.7	40.6	945	0.0480
2/9	25	10:36 PM	2/9/03 22:36	25.19	93.1	21.1	44.4	928	0.0410
2/10	26	11:10 AM	2/10/03 11:10	25.72	93.1	10.8	60.8	936	0.0210
2/10	26	10:10 PM	2/10/03 22:10	26.17	93.1	7.68	69.3	912	0.0149
2/11	27	11:54 AM	2/11/03 11:54	26.75	93.1	5.47	77.4	900	0.0106
2/12	28	11:50 AM	2/12/03 11:50	27.74	95.6	3.31	90.4	909	0.0064
2/13	29	11:20 AM	2/13/03 11:20	28.72	95.6	2.28	99.6	901	0.0044
2/14	30	11:30 AM	2/14/03 11:30	29.73	95.6	1.68	107.1	903	0.0033
2/15	31	3:15 PM	2/15/03 15:15	30.89	96.6	1.63	110.1	878	0.0032
2/16	32	10:15 AM	2/16/03 10:15	31.68	96.6	1.27	116.3	926	0.0025
2/17	33	10:45 AM	2/17/03 10:45	32.70	96.1	1.29	116.5	902	0.0025
2/18	34	6:12 AM	2/18/03 6:12	33.51	96.1	1.15	119.4	907	0.0022

Table C-4. Test 3 Outlet Data. E) Column 5 (Continued)

Column # 5 Outlet				Location (cm)	194.2	EC (uS/cm)	1800	Br- (mg/L)	497
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	1.07	107.8	1050	0.0022
1/16	1	4:55 PM	1/16/03 16:55	0.95	95.3	1.05	110.2	918	0.0021
1/17	2	3:10 PM	1/17/03 15:10	1.88	95.3	1.03	110.5	922	0.0021
1/18	3	11:25 AM	1/18/03 11:25	2.73	95.3	0.994	111.4	910	0.0020
1/19	4	11:40 AM	1/19/03 11:40	3.74	92.2	0.855	116.6	951	0.0017
1/20	5	11:00 AM	1/20/03 11:00	4.71	92.2	0.855	116.6	913	0.0017
1/21	6	2:55 PM	1/21/03 14:55	5.87	94.1	0.620	132.3	1010	0.0012
1/22	7	12:05 PM	1/22/03 12:05	6.75	94.1	0.661	130.7	1020	0.0013
1/23	8	11:10 AM	1/23/03 11:10	7.72	94.1	0.661	130.6	1030	0.0013
1/24	9	3:10 PM	1/24/03 15:10	8.88	93.4	0.796	126.2	893	0.0016
1/25	10	10:30 AM	1/25/03 10:30	9.69	93.4	0.779	126.7	917	0.0016
1/26	11	11:35 AM	1/26/03 11:35	10.73	93.9	0.831	124.7	893	0.0017
1/27	12	3:00 PM	1/27/03 15:00	11.88	93.9	0.784	126.2	895	0.0016
1/28	13	2:10 PM	1/28/03 14:10	12.84	91.4	1.27	115.5	895	0.0026
1/29	14	11:50 AM	1/29/03 11:50	13.74	91.4	0.989	121.3	932	0.0020
1/30	15	4:35 PM	1/30/03 16:35	14.94	96.1	1.55	112.5	960	0.0031
1/31	16	11:55 AM	1/31/03 11:55	15.75	96.1	2.75	98.3	957	0.0055
1/31	16	11:38 PM	1/31/03 23:38	16.23	94.6	6.78	74.7	910	0.0136
2/1	17	10:35 AM	2/1/03 10:35	16.69	94.6	11.6	61.1	978	0.0233
2/1	17	11:13 PM	2/1/03 23:13	17.22	94.6	20.6	46.4	919	0.0414
2/2	18	10:30 AM	2/2/03 10:30	17.69	96.3	33.3	33.7	981	0.0670
2/3	19	11:20 AM	2/3/03 11:20	18.72	96.3	56.1	20.4	1020	0.1129
2/3	19	10:51 PM	2/3/03 22:51	19.20	96.3	71.5	14.3	999	0.1439
2/4	20	1:20 PM	2/4/03 13:20	19.81	94.3	79.5	12.4	995	0.1600
2/4	20	10:48 PM	2/4/03 22:48	20.20	94.3	89.2	9.6	990	0.1795
2/5	21	7:35 AM	2/5/03 7:35	20.57	94.3	90.2	9.3	1000	0.1815
2/5	21	6:13 PM	2/5/03 18:13	21.01	94.3	94.6	8.1	985	0.1903
2/6	22	11:20 AM	2/6/03 11:20	21.72	94.3	84.0	11.0	993	0.1690
2/6	22	9:18 PM	2/6/03 21:18	22.14	94.4	77.5	11.8	1000	0.1559
2/7	23	7:00 AM	2/7/03 7:00	22.54	94.4	69.9	14.3	1000	0.1406
2/7	23	6:22 PM	2/7/03 18:22	23.02	94.4	61.4	17.5	1020	0.1235
2/8	24	6:35 AM	2/8/03 6:35	23.52	93.1	56.1	20.4	978	0.1129
2/8	24	6:50 PM	2/8/03 18:50	24.03	93.1	40.8	28.2	978	0.0821
2/9	25	10:10 AM	2/9/03 10:10	24.67	93.1	30.8	35.2	927	0.0620
2/9	25	10:31 PM	2/9/03 22:31	25.19	93.1	25.3	40.0	974	0.0509
2/10	26	11:05 AM	2/10/03 11:05	25.71	93.1	21.2	44.3	952	0.0427
2/10	26	10:05 PM	2/10/03 22:05	26.17	93.1	16.0	51.3	946	0.0322
2/11	27	11:46 AM	2/11/03 11:46	26.74	93.1	11.0	60.4	941	0.0221
2/12	28	11:40 AM	2/12/03 11:40	27.74	95.6	5.54	77.8	922	0.0111
2/13	29	11:10 AM	2/13/03 11:10	28.72	95.6	3.21	91.2	871	0.0065
2/14	30	11:20 AM	2/14/03 11:20	29.72	95.6	2.06	102.1	893	0.0041
2/15	31	3:03 PM	2/15/03 15:03	30.88	96.6	1.46	112.8	904	0.0029
2/16	32	10:05 AM	2/16/03 10:05	31.67	96.6	1.27	116.4	904	0.0026
2/17	33	10:35 AM	2/17/03 10:35	32.69	96.1	1.20	118.4	901	0.0024
2/18	34	6:10 AM	2/18/03 6:10	33.51	96.1	1.12	119.9	930	0.0023

Table C-4. Test 3 Outlet Data. F) Column 6 (Continued)

Column # 6 Outlet				Location (cm)	192.8	EC (uS/cm)	1800	Br- (mg/L)	537
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	0.871	112.8	1090	0.0016
1/16	1	5:00 PM	1/16/03 17:00	0.96	95.3	0.999	111.3	944	0.0019
1/17	2	3:15 PM	1/17/03 15:15	1.89	95.3	1.00	111.2	937	0.0019
1/18	3	11:30 AM	1/18/03 11:30	2.73	95.3	1.01	110.9	928	0.0019
1/19	4	11:45 AM	1/19/03 11:45	3.74	92.2	0.939	114.3	925	0.0017
1/20	5	11:05 AM	1/20/03 11:05	4.71	92.2	0.876	116.0	915	0.0016
1/21	6	3:00 PM	1/21/03 15:00	5.88	94.1	0.698	129.4	1020	0.0013
1/22	7	12:15 PM	1/22/03 12:15	6.76	94.1	0.696	129.7	1020	0.0013
1/23	8	11:15 AM	1/23/03 11:15	7.72	94.1	0.714	128.7	1040	0.0013
1/24	9	3:15 PM	1/24/03 15:15	8.89	93.4	0.767	127.1	902	0.0014
1/25	10	10:35 AM	1/25/03 10:35	9.69	93.4	0.773	126.9	910	0.0014
1/26	11	11:40 AM	1/26/03 11:40	10.74	93.9	0.818	125.1	901	0.0015
1/27	12	3:05 PM	1/27/03 15:05	11.88	93.9	0.805	125.5	895	0.0015
1/28	13	2:20 PM	1/28/03 14:20	12.85	91.4	2.15	103.1	902	0.0040
1/29	14	11:55 AM	1/29/03 11:55	13.75	91.4	5.64	80.4	904	0.0105
1/30	15	4:40 PM	1/30/03 16:40	14.94	96.1	17.7	51.5	940	0.0330
1/31	16	12:00 PM	1/31/03 12:00	15.75	96.1	30.3	37.6	993	0.0564
1/31	16	11:42 PM	1/31/03 23:42	16.24	94.6	38.0	30.7	933	0.0708
2/1	17	10:40 AM	2/1/03 10:40	16.69	94.6	45.4	26.2	1050	0.0845
2/1	17	11:18 PM	2/1/03 23:18	17.22	94.6	49.8	23.8	941	0.0927
2/2	18	10:35 AM	2/2/03 10:35	17.69	96.3	56.1	20.4	938	0.1045
2/3	19	11:30 AM	2/3/03 11:30	18.73	96.3	54.6	21.1	986	0.1017
2/3	19	10:54 PM	2/3/03 22:54	19.20	96.3	55.7	20.6	975	0.1037
2/4	20	1:25 PM	2/4/03 13:25	19.81	94.3	47.6	24.9	946	0.0886
2/4	20	10:51 PM	2/4/03 22:51	20.20	94.3	42.2	27.9	933	0.0786
2/5	21	7:40 AM	2/5/03 7:40	20.57	94.3	40.9	28.6	949	0.0762
2/5	21	6:17 PM	2/5/03 18:17	21.01	94.3	35.5	32.1	930	0.0661
2/6	22	11:25 AM	2/6/03 11:25	21.73	94.3	24.8	40.9	940	0.0462
2/6	22	9:23 PM	2/6/03 21:23	22.14	94.4	19.9	45.2	988	0.0371
2/7	23	7:03 AM	2/7/03 7:03	22.54	94.4	15.4	51.4	933	0.0287
2/7	23	6:27 PM	2/7/03 18:27	23.02	94.4	10.9	59.8	930	0.0203
2/8	24	6:31 AM	2/8/03 6:31	23.52	93.1	7.23	70.7	923	0.0135
2/8	24	6:55 PM	2/8/03 18:55	24.04	93.1	5.36	77.9	899	0.0100
2/9	25	10:15 AM	2/9/03 10:15	24.68	93.1	3.11	90.9	884	0.0058
2/9	25	10:34 PM	2/9/03 22:34	25.19	93.1	2.19	99.3	899	0.0041
2/10	26	11:10 AM	2/10/03 11:10	25.72	93.1	2.24	98.7	906	0.0042
2/10	26	10:05 PM	2/10/03 22:05	26.17	93.1	1.68	105.7	903	0.0031
2/11	27	11:52 AM	2/11/03 11:52	26.74	93.1	1.38	110.4	884	0.0026
2/12	28	11:50 AM	2/12/03 11:50	27.74	95.6	1.36	112.3	889	0.0025
2/13	29	11:15 AM	2/13/03 11:15	28.72	95.6	1.09	117.7	902	0.0020
2/14	30	11:25 AM	2/14/03 11:25	29.73	95.6	0.956	121.0	906	0.0018
2/15	31	3:10 PM	2/15/03 15:10	30.88	96.6	1.03	121.6	917	0.0019
2/16	32	10:15 AM	2/16/03 10:15	31.68	96.6	0.943	123.8	913	0.0018
2/17	33	10:40 AM	2/17/03 10:40	32.69	96.1	1.03	122.0	919	0.0019
2/18	34	6:09 AM	2/18/03 6:09	33.51	96.1	0.963	123.8	925	0.0018

Table C-4. Test 3 Outlet Data. G) Column 7 (Continued)

Column # 7 Outlet				Location (cm)	191.2	EC (uS/cm)	1790	Br- (mg/L)	505
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	0.947	110.7	1140	0.0019
1/16	1	4:55 PM	1/16/03 16:55	0.95	95.3	1.14	108.0	964	0.0023
1/17	2	3:10 PM	1/17/03 15:10	1.88	95.3	1.05	110.2	970	0.0021
1/18	3	11:25 AM	1/18/03 11:25	2.73	95.3	1.03	110.5	966	0.0020
1/19	4	11:40 AM	1/19/03 11:40	3.74	92.2	0.951	114.0	970	0.0019
1/20	5	11:00 AM	1/20/03 11:00	4.71	92.2	0.855	116.6	942	0.0017
1/21	6	2:55 PM	1/21/03 14:55	5.87	94.1	0.740	127.0	1040	0.0015
1/22	7	12:10 PM	1/22/03 12:10	6.76	94.1	0.738	127.8	1030	0.0015
1/23	8	11:10 AM	1/23/03 11:10	7.72	94.1	0.718	128.6	1040	0.0014
1/24	9	3:10 PM	1/24/03 15:10	8.88	93.4	0.764	1272	891	0.0015
1/25	10	10:30 AM	1/25/03 10:30	9.69	93.4	0.755	127.5	897	0.0015
1/26	11	11:35 AM	1/26/03 11:35	10.73	93.9	0.818	125.1	900	0.0016
1/27	12	3:00 PM	1/27/03 15:00	11.88	93.9	0.787	126.1	880	0.0016
1/28	13	2:15 PM	1/28/03 14:15	12.84	91.4	2.40	100.5	889	0.0048
1/29	14	11:15 AM	1/29/03 11:15	13.72	91.4	7.69	73.0	916	0.0152
1/30	15	4:35 PM	1/30/03 16:35	14.94	96.1	28.8	38.9	969	0.0570
1/31	16	11:55 AM	1/31/03 11:55	15.75	96.1	48.4	25.6	972	0.0958
1/31	16	11:44 PM	1/31/03 23:44	16.24	94.6	64.3	17.3	921	0.1273
2/1	17	10:35 AM	2/1/03 10:35	16.69	94.6	72.8	14.1	1060	0.1442
2/1	17	11:14 PM	2/1/03 23:14	17.22	94.6	80.6	11.5	957	0.1596
2/2	18	10:30 AM	2/2/03 10:30	17.69	96.3	91.2	8.2	1010	0.1806
2/3	19	11:20 AM	2/3/03 11:20	18.72	96.3	90.2	8.5	1030	0.1786
2/3	19	10:51 PM	2/3/03 22:51	19.20	96.3	85.8	9.7	1030	0.1699
2/4	20	1:20 PM	2/4/03 13:20	19.81	94.3	93.2	8.5	990	0.1846
2/4	20	10:43 PM	2/4/03 22:43	20.20	94.3	72.8	14.5	970	0.1442
2/5	21	7:35 AM	2/5/03 7:35	20.57	94.3	65.3	17.2	949	0.1293
2/5	21	6:17 PM	2/5/03 18:17	21.01	94.3	55.2	21.3	955	0.1093
2/6	22	11:20 AM	2/6/03 11:20	21.72	94.3	44.1	26.8	949	0.0873
2/6	22	9:20 PM	2/6/03 21:20	22.14	94.4	33.8	32.1	950	0.0669
2/7	23	7:00 AM	2/7/03 7:00	22.54	94.4	28.4	36.4	979	0.0562
2/7	23	6:24 PM	2/7/03 18:24	23.02	94.4	22.3	42.2	982	0.0442
2/8	24	6:35 AM	2/8/03 6:35	23.52	93.1	15.5	52.0	946	0.0307
2/8	24	6:50 PM	2/8/03 18:50	24.03	93.1	11.6	59.1	941	0.0230
2/9	25	10:10 AM	2/9/03 10:10	24.67	93.1	8.06	68.0	906	0.0160
2/9	25	10:32 PM	2/9/03 22:32	25.19	93.1	6.07	74.9	950	0.0120
2/10	26	11:05 AM	2/10/03 11:05	25.71	93.1	4.51	82.0	903	0.0089
2/10	26	10:07 PM	2/10/03 22:07	26.17	93.1	3.44	88.5	930	0.0068
2/11	27	11:46 AM	2/11/03 11:46	26.74	93.1	2.77	93.7	919	0.0055
2/12	28	11:45 AM	2/12/03 11:45	27.74	95.6	1.69	107.0	877	0.0033
2/13	29	11:10 AM	2/13/03 11:10	28.72	95.6	1.43	111.1	902	0.0028
2/14	30	11:20 AM	2/14/03 11:20	29.72	95.6	1.23	114.7	888	0.0024
2/15	31	3:05 PM	2/15/03 15:05	30.88	96.6	1.05	121.1	908	0.0021
2/16	32	10:10 AM	2/16/03 10:10	31.67	96.6	1.07	120.7	907	0.0021
2/17	33	10:35 AM	2/17/03 10:35	32.69	96.1	1.04	121.8	905	0.0021
2/18	34	6:10 AM	2/18/03 6:10	33.51	96.1	1.06	121.3	899	0.0021
			Peak day avg	18.75				Peak C/C_0 avg	0.1826

Table C-4. Test 3 Outlet Data. H) Column 8 (Continued)

Column # 8 Outlet				Location (cm)	190.4	EC (uS/cm)	1710	Br- (mg/L)	423
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	1.03	108.7	1030	0.0024
1/16	1	5:00 PM	1/16/03 17:00	0.96	95.3	0.943	112.7	906	0.0022
1/17	2	3:20 PM	1/17/03 15:20	1.89	95.3	0.928	113.1	912	0.0022
1/18	3	11:30 AM	1/18/03 11:30	2.73	95.3	0.926	113.2	907	0.0022
1/19	4	11:50 AM	1/19/03 11:50	3.74	92.2	0.899	115.4	940	0.0021
1/20	5	11:05 AM	1/20/03 11:05	4.71	92.2	0.876	116.0	910	0.0021
1/21	6	3:00 PM	1/21/03 15:00	5.88	94.1	0.784	126.4	999	0.0019
1/22	7	12:15 PM	1/22/03 12:15	6.76	94.1	0.778	126.6	1020	0.0018
1/23	8	11:20 AM	1/23/03 11:20	7.72	94.1	0.796	126.0	1030	0.0019
1/24	9	3:15 PM	1/24/03 15:15	8.89	93.4	0.805	125.9	912	0.0019
1/25	10	10:35 AM	1/25/03 10:35	9.69	93.4	0.798	126.1	926	0.0019
1/26	11	11:40 AM	1/26/03 11:40	10.74	93.9	0.862	123.8	915	0.0020
1/27	12	3:05 PM	1/27/03 15:05	11.88	93.9	0.774	126.5	903	0.0018
1/28	13	2:20 PM	1/28/03 14:20	12.85	91.4	1.31	114.9	893	0.0031
1/29	14	12:00 PM	1/29/03 12:00	13.75	91.4	1.59	110.2	911	0.0038
1/30	15	4:40 PM	1/30/03 16:40	14.94	96.1	7.02	76.2	977	0.0166
1/31	16	12:05 PM	1/31/03 12:05	15.75	96.1	16.5	53.4	990	0.0390
1/31	16	11:47 PM	1/31/03 23:47	16.24	94.6	23.6	43.0	932	0.0558
2/1	17	10:45 AM	2/1/03 10:45	16.70	94.6	31.8	35.3	981	0.0752
2/1	17	11:23 PM	2/1/03 23:23	17.22	94.6	42.8	27.7	961	0.1012
2/2	18	10:30 AM	2/2/03 10:30	17.69	96.3	53.6	21.6	979	0.1267
2/3	19	11:25 AM	2/3/03 11:25	18.73	96.3	67.6	15.7	983	0.1598
2/3	19	10:51 PM	2/3/03 22:51	19.20	96.3	73.1	13.7	996	0.1728
2/4	20	1:20 PM	2/4/03 13:20	19.81	94.3	82.6	11.4	989	0.1953
2/4	20	10:42 PM	2/4/03 22:42	20.20	94.3	80.0	12.2	985	0.1891
2/5	21	7:35 AM	2/5/03 7:35	20.57	94.3	78.4	12.7	987	0.1853
2/5	21	6:16 PM	2/5/03 18:16	21.01	94.3	82.6	11.4	959	0.1953
2/6	22	11:20 AM	2/6/03 11:20	21.72	94.3	67.4	16.4	968	0.1593
2/6	22	9:23 PM	2/6/03 21:23	22.14	94.4	64.7	16.2	979	0.1530
2/7	23	7:02 AM	2/7/03 7:02	22.54	94.4	56.1	19.7	995	0.1326
2/7	23	6:23 PM	2/7/03 18:23	23.02	94.4	47.1	24.0	1030	0.1113
2/8	24	6:35 AM	2/8/03 6:35	23.52	93.1	37.9	30.0	982	0.0896
2/8	24	6:50 PM	2/8/03 18:50	24.03	93.1	32.7	33.7	950	0.0773
2/9	25	10:10 AM	2/9/03 10:10	24.67	93.1	27.1	38.3	920	0.0641
2/9	25	10:33 PM	2/9/03 22:33	25.19	93.1	22.5	42.8	945	0.0532
2/10	26	11:05 AM	2/10/03 11:05	25.71	93.1	17.6	48.9	932	0.0416
2/10	26	10:10 PM	2/10/03 22:10	26.17	93.1	13.5	55.4	932	0.0319
2/11	27	11:05 AM	2/11/03 11:05	26.71	93.1	9.38	64.4	941	0.0222
2/12	28	12:00 PM	2/12/03 12:00	27.75	95.6	4.55	82.6	920	0.0108
2/13	29	11:15 AM	2/13/03 11:15	28.72	95.6	2.90	93.7	912	0.0069
2/14	30	11:35 AM	2/14/03 11:35	29.73	95.6	2.00	102.9	942	0.0047
2/15	31	3:10 PM	2/15/03 15:10	30.88	96.6	1.37	114.5	890	0.0032
2/16	32	10:15 AM	2/16/03 10:15	31.68	96.6	1.21	117.6	922	0.0029
2/17	33	10:40 AM	2/17/03 10:40	32.69	96.1	1.17	118.9	937	0.0028
2/18	34	6:15 AM	2/18/03 6:15	33.51	96.1	1.08	121.0	926	0.0026
			Peak day avg	20.41					

Table C-4. Test 3 Outlet Data. I) Column 9 (Continued)

Column # 9 Outlet				Location (cm)	187.9	EC (uS/cm)	1794	Br- (mg/L)	491
	(Day 0=Start of Tracer Application)								
Date	Day Number	Time	1/15/03 18:00	Real Day	Slope (%)	Br- (mg/L)	EP (mV)	EC (uS/cm)	Br- Ratio
1/15	0	7:00 PM	1/15/03 19:00	0.04	92.9	0.909	111.7	1070	0.0019
1/16	1	5:00 PM	1/16/03 17:00	0.96	95.3	0.926	113.2	925	0.0019
1/17	2	3:20 PM	1/17/03 15:20	1.89	95.3	0.928	113.2	911	0.0019
1/18	3	11:30 AM	1/18/03 11:30	2.73	95.3	0.921	113.3	913	0.0019
1/19	4	11:50 AM	1/19/03 11:50	3.74	92.2	0.878	115.9	958	0.0018
1/20	5	11:05 AM	1/20/03 11:05	4.71	92.2	0.792	118.4	910	0.0016
1/21	6	2:55 PM	1/21/03 14:55	5.87	94.1	0.779	126.5	991	0.0016
1/22	7	12:10 PM	1/22/03 12:10	6.76	94.1	0.770	126.8	1020	0.0016
1/23	8	11:15 AM	1/23/03 11:15	7.72	94.1	0.767	126.9	1000	0.0016
1/24	9	3:15 PM	1/24/03 15:15	8.89	93.4	0.792	126.3	901	0.0016
1/25	10	10:35 AM	1/25/03 10:35	9.69	93.4	0.779	126.7	916	0.0016
1/26	11	11:40 AM	1/26/03 11:40	10.74	93.9	0.849	124.2	887	0.0017
1/27	12	3:05 PM	1/27/03 15:05	11.88	93.9	0.888	123.1	877	0.0018
1/28	13	2:20 PM	1/28/03 14:20	12.85	91.4	1.89	106.1	896	0.0038
1/29	14	12:00 PM	1/29/03 12:00	13.75	91.4	5.34	81.7	909	0.0109
1/30	15	4:35 PM	1/30/03 16:35	14.94	96.1	14.6	56.5	971	0.0297
1/31	16	12:05 PM	1/31/03 12:05	15.75	96.1	24.3	43.4	1010	0.0495
1/31	16	11:43 PM	1/31/03 23:43	16.24	94.6	31.1	35.9	921	0.0633
2/1	17	10:40 AM	2/1/03 10:40	16.69	94.6	36.1	32.1	991	0.0735
2/1	17	11:20 PM	2/1/03 23:20	17.22	94.6	45.2	26.3	962	0.0921
2/2	18	10:35 AM	2/2/03 10:35	17.69	96.3	55.7	20.6	967	0.1134
2/3	19	11:30 AM	2/3/03 11:30	18.73	96.3	63.4	17.3	972	0.1291
2/3	19	10:54 PM	2/3/03 22:54	19.20	96.3	67.3	15.8	982	0.1371
2/4	20	1:30 PM	2/4/03 13:30	19.81	94.3	75.9	13.5	967	0.1546
2/4	20	10:51 PM	2/4/03 22:51	20.20	94.3	77.2	13.1	990	0.1572
2/5	21	7:45 AM	2/5/03 7:45	20.57	94.3	75.7	13.6	960	0.1542
2/5	21	6:19 PM	2/5/03 18:19	21.01	94.3	84.4	10.9	997	0.1719
2/6	22	11:25 AM	2/6/03 11:25	21.73	94.3	74.2	14.1	965	0.1511
2/6	22	9:25 PM	2/6/03 21:25	22.14	94.4	69.4	14.5	1020	0.1413
2/7	23	7:03 AM	2/7/03 7:03	22.54	94.4	65.5	15.9	1030	0.1334
2/7	23	6:29 PM	2/7/03 18:29	23.02	94.4	59.2	18.4	1020	0.1206
2/8	24	6:35 AM	2/8/03 6:35	23.52	93.1	50.2	23.1	968	0.1022
2/8	24	7:00 PM	2/8/03 19:00	24.04	93.1	43.8	26.5	940	0.0892
2/9	25	10:20 AM	2/9/03 10:20	24.68	93.1	33.7	33.0	925	0.0686
2/9	25	10:36 PM	2/9/03 22:36	25.19	93.1	26.4	38.9	945	0.0538
2/10	26	11:10 AM	2/10/03 11:10	25.72	93.1	21.1	44.5	920	0.0430
2/10	26	10:09 PM	2/10/03 22:09	26.17	93.1	15.5	52.1	899	0.0316
2/11	27	11:54 AM	2/11/03 11:54	26.75	93.1	11.1	60.2	915	0.0226
2/12	28	11:50 AM	2/12/03 11:50	27.74	95.6	5.59	77.6	908	0.0114
2/13	29	11:20 AM	2/13/03 11:20	28.72	95.6	3.07	92.3	903	0.0063
2/14	30	11:26 AM	2/14/03 11:26	29.73	95.6	1.93	103.7	918	0.0039
2/15	31	3:15 PM	2/15/03 15:15	30.89	96.6	1.35	114.9	868	0.0027
2/16	32	10:15 AM	2/16/03 10:15	31.68	96.6	1.15	118.9	899	0.0023
2/17	33	10:40 AM	2/17/03 10:40	32.69	96.1	1.20	118.4	925	0.0024
2/18	34	6:11 AM	2/18/03 6:11	33.51	96.1	1.07	121.2	923	0.0022

Table C-5. Test 3 Outlet CXTFIT Data. A) Column 1 (2 pages)

```
*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: outletin.in                                 *
*                                                               *
*****************************************************************

MODEL DESCRIPTION
=================
 DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
 FLUX-AVERAGED CONCENTRATION
 REAL TIME (t), POSITION(x)
  (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
 V.......   .9144E+01      Y
 D.......   .1830E+02      Y
 R.......   .1000E+01      N
 mu......   .0000E+00      N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =   1.0000 & DURATION =   1.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ        V.....     D.....
 0   .1542E-01  .914E+01  .183E+02
 1   .5748E-02  .950E+01  .231E+02
 2   .5392E-02  .960E+01  .227E+02
 3   .5386E-02  .960E+01  .230E+02
 4   .5386E-02  .960E+01  .230E+02
 5   .5386E-02  .960E+01  .230E+02
 6   .5386E-02  .960E+01  .230E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....  D....
 V....  1.000
 D....  -.163  1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .95329464
 (COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .1252E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                              95% CONFIDENCE LIMITS
NAME    VALUE     S.E.COEFF.  T-VALUE    LOWER      UPPER
V....  .9599E+01  .6163E-01  .1557E+03  .9475E+01  .9724E+01
D....  .2298E+02  .1466E+01  .1567E+02  .2002E+02  .2593E+02
```

-----------------ORDERED BY COMPUTER INPUT------------------

			CONCENTRATION		RESI-
NO	DISTANCE	TIME	OBS	FITTED	DUAL
1	193 6	0.0417	0.0026	0	0.0026
2	193.6	0 9514	0.002	0	0.002
3	193.6	1.8854	0.002	0	0.002
4	193.6	2.7222	0.0021	0	0.0021
5	193.6	3.7431	0.0022	0	0 0022
6	193.6	4.7083	0.0018	0	0 0018
7	193.6	5.8646	0.0014	0	0.0014
8	193.6	6.7535	0.0014	0	0 0014
9	193.6	7.7153	0.0011	0	0.0011
10	193.6	8.8819	0.0024	0	0.0024
11	193.6	9.6875	0.0019	0	0.0019
12	193.6	10.7326	0.0021	0	0.0021
13	193.6	11.8715	0.002	0.0004	0.0016
14	193.6	12.8438	0.008	0.002	0.006
15	193 6	13.7431	0.0175	0.0066	0.011
16	193.6	14.941	0.0373	0.0217	0.0156
17	193.6	15.7465	0.06	0.0392	0.0208
18	193.6	16.2326	0.07	0.0523	0.0177
19	193.6	16.691	0.09	0.0657	0 0243
20	193.6	17.2167	0 1	0 0815	0.0185
21	193 6	17.684	0.11	0.0949	0.0151
22	193.6	18.7222	0.12	0.1184	0.0016
23	193.6	19 2028	0.13	0.125	0 005
24	193 6	19.8056	0.13	0.1286	0.0014
25	193.6	20.2007	0 13	0.1283	0.0017
26	193.6	20.566	0.14	0.1262	0 0138
27	193.6	21.009	0.14	0.1216	0.0184
28	193.6	21.7188	0.12	0.1104	0.0096
29	193.6	22.1368	0.11	0.1023	0.0077
30	193.6	22.5417	0.11	0.0938	0.0162
31	193.6	23.0153	0.1	0.0835	0.0165
32	193.6	23.5222	0.09	0.0724	0.0176
33	193.6	24 0347	0.08	0.0617	0.0183
34	193.6	24.6701	0 07	0.0495	0.0205
35	193.6	25.1889	0 06	0.0407	0.0193
36	193.6	25 7118	0 04	0 0329	0.0071
37	193.6	26.1708	0 04	0 027	0.013
38	193.6	26.7403	0 03	0 0209	0.0091
39	193.6	27.7396	0.01	0 0128	-0.0028
40	193.6	28.7153	0.01	0 0077	0.0023
41	193 6	29.7222	0	0.0044	-0.0044
42	193.6	30.8785	0	0 0022	-0.0022
43	193.6	31.6736	0	0.0014	-0.0014
44	193.6	32.691	0	0.0007	-0.0007
45	193.6	33.509	0	0.0004	-0.0004

(Table continued on next page)

Table C-5. Test 3 Outlet CXTFIT Data. B) Column 2 (2 pages) (Continued)

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: outletin.in                                *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
FLUX-AVERAGED CONCENTRATION
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V.......	.9144E+01	Y
D.......	.1830E+02	Y
R.......	.1000E+01	N
mu......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 1.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.4613E-01	.914E+01	.183E+02
1	.1767E-01	.823E+01	.196E+02
2	.7231E-02	.839E+01	.134E+02
3	.6448E-02	.843E+01	.111E+02
4	.6372E-02	.841E+01	.116E+02
5	.6370E-02	.841E+01	.115E+02
6	.6370E-02	.841E+01	.115E+02
7	.6370E-02	.841E+01	.115E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.152	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .95621078
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .1481E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF	T-VALUE	LOWER	UPPER
V....	.8412E+01	.4053E-01	.2076E+03	.8330E+01	.8494E+01
D....	.1150E+02	.7568E+00	.1520E+02	.9977E+01	.1303E+02

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESIDUAL
1	192.1	0.0417	0.0021	0	0.0021
2	192.1	0.9583	0.0022	0	0.0022
3	192.1	1.8889	0.0022	0	0.0022
4	192.1	2.7292	0.0022	0	0.0022
5	192.1	3.7431	0.0019	0	0.0019
6	192.1	4.7153	0.0018	0	0.0018
7	192.1	5.875	0.0011	0	0.0011
8	192.1	6.7604	0.0011	0	0.0011
9	192.1	7.7222	0.0011	0	0.0011
10	192.1	8.8889	0.0018	0	0.0018
11	192.1	9.6944	0.0016	0	0.0016
12	192.1	10.7396	0.0018	0	0.0018
13	192.1	11.8785	0.0015	0	0.0015
14	192.1	12.8472	0.0027	0	0.0027
15	192.1	13.75	0.0022	0	0.0022
16	192.1	14.9479	0.0046	0.0002	0.0044
17	192.1	15.7535	0.0064	0.0009	0.0055
18	192.1	16.2403	0.0113	0.002	0.0092
19	192.1	16.6944	0.016	0.004	0.0121
20	192.1	17.2201	0.0234	0.0079	0.0155
21	192.1	17.691	0.033	0.0134	0.0196
22	192.1	18.7292	0.0568	0.0348	0.022
23	192.1	19.2076	0.0764	0.0491	0.0274
24	192.1	19.809	0.0841	0.0701	0.014
25	192.1	20.2028	0.0987	0.0849	0.0139
26	192.1	20.5694	0.1106	0.0986	0.012
27	192.1	21.0146	0.1246	0.1143	0.0103
28	192.1	21.7257	0.1407	0.1346	0.0061
29	192.1	22.1389	0.1441	0.1425	0.0016
30	192.1	22.5458	0.1459	0.1469	-0.001
31	192.1	23.0188	0.1472	0.1476	-0.0005
32	192.1	23.525	0.1714	0.1436	0.0278
33	192.1	24.0417	0.1497	0.1349	0.0148
34	192.1	24.6806	0.1403	0.1195	0.0208
35	192.1	25.191	0.1317	0.105	0.0267
36	192.1	25.7153	0.1048	0.0894	0.0154
37	192.1	26.1722	0.0937	0.076	0.0177
38	192.1	26.7451	0.0783	0.0604	0.0179
39	192.1	27.7431	0.052	0.0378	0.0141
40	192.1	28.7222	0.034	0.0222	0.0118
41	192.1	29.7257	0.02	0.012	0.0081
42	192.1	30.8854	0.0111	0.0054	0.0056
43	192.1	31.6771	0.0079	0.003	0.0049
44	192.1	32.6979	0.0054	0.0014	0.004
45	192.1	33.5097	0.004	0.0007	0.0033

Table C-5. Test 3 Outlet CXTFIT Data. C) Column 3 (2 pages) (Continued)

```
*******************************************************************
*                                                                 *
*   CXTFIT VERSION 2.1 (4/17/99)                                  *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                  *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                             *
*                                                                 *
*   Comment                                                       *
*   Comment                                                       *
*                                                                 *
*   DATA INPUT FILE: outletin in                                  *
*                                                                 *
*******************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME     INITIAL VALUE  FITTING
V.......  .9144E+01     Y
D.......  .1830E+02     Y
R.......  .1000E+01     N
mu......  .0000E+00     N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =  1.0000 & DURATION =  1.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ       V....     D....
 0  .7095E-01 .914E+01 .183E+02
 1  .3891E-01 .815E+01 .105E+02
 2  .1760E-01 .867E+01 .791E+01
 3  .1529E-01 .856E+01 .878E+01
 4  .1514E-01 .856E+01 .817E+01
 5  .1513E-01 .855E+01 .834E+01
 6  .1513E-01 .855E+01 .829E+01
 7  .1513E-01 .855E+01 .830E+01
 8  .1513E-01 .855E+01 .830E+01

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
         V....  D....
  V....  1.000
  D....  -.163  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED =.93019228
   (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .3518E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                               95% CONFIDENCE LIMITS
NAME    VALUE    S.E.COEFF. T-VALUE   LOWER      UPPER
V....  .8554E+01  .4723E-01 .1811E+03  .8459E+01  .8649E+01
D....  .8302E+01  .7548E+00 .1100E+02  .6780E+01  .9825E+01
```

-----------------ORDERED BY COMPUTER INPUT------------------

CONCENTRATION RESI-

S NO DISTANCE TIME OBS FITTED DUAL

1	193.5	0 0417	0.0018	0	0.0018
2	193.5	0 9549	0.0019	0	0.0019
3	193.5	1 8854	0.002	0	0.002
4	193.5	2.7257	0.002	0	0.002
5	193.5	3.7361	0.0018	0	0.0018
6	193.5	4.7083	0.0016	0	0.0016
7	193.5	5 8681	0.001	0	0.001
8	193.5	6 7569	0.001	0	0.001
9	193.5	7.7188	0.001	0	0.001
10	193.5	8 8819	0.0016	0	0.0016
11	193.5	9.6875	0.0015	0	0.0015
12	193.5	10.7326	0.0016	0	0.0016
13	193.5	11.875	0.0014	0	0.0014
14	193.5	12.8438	0.0019	0	0.0019
15	193.5	13.7465	0.0017	0	0 0017
16	193.5	14.941	0.0023	0	0.0023
17	193.5	15.7465	0.0023	0.0002	0.0021
18	193.5	16 2347	0.0042	0.0005	0.0037
19	193.5	16.691	0.0061	0.0012	0.0049
20	193.5	17.2181	0.0122	0.0031	0.0091
21	193.5	17.6875	0.0226	0.0065	0.0161
22	193.5	19.2257	0.0568	0.0401	0.0167
23	193.5	19 2028	0.083	0.0392	0 0438
24	193.5	19.8056	0.1079	0.0643	0 0436
25	193.5	20.2014	0.1166	0.0838	0 0328
26	193.5	20.566	0.123	0.1029	0.0201
27	193.5	21.0104	0.1442	0.1259	0.0183
28	193.5	21.7222	0.1699	0.157	0.0129
29	193 5	22.1389	0.1807	0.1692	0.0115
30	193.5	22.5424	0.1888	0.1755	0 0133
31	193.5	23.0153	0.1913	0.1757	0.0156
32	193.5	23.5243	0.1913	0.1677	0.0236
33	193.5	24.0347	0.1819	0.1527	0.0291
34	193.5	24.6736	0.1645	0 1277	0.0368
35	193.5	25 1896	0.1475	0.1055	0 042
36	193.5	25.7118	0.118	0.0836	0.0344
37	193 5	26 1722	0.0979	0.066	0 0319
38	193.5	26.741	0.077	0 0474	0.0296
39	193 5	27.7396	0.0409	0.0242	0.0168
40	193.5	28.7153	0.0214	0.0113	0.0102
41	193.5	29.7222	0.0106	0.0046	0.006
42	193.5	30.8785	0.0063	0.0015	0.0048
43	193.5	31.6736	0.0045	0.0006	0.0038
44	193.5	32.691	0.0036	0 0002	0.0034
45	193.5	33.509	0.0031	0.0001	0 003

Table C-5. Test 3 Outlet CXTFIT Data. D) Column 4 (2 pages) (Continued)

```
*****************************************************************
*                                  *
*  CXTFIT VERSION 2.1 (4/17/99)              *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE        *
*  NON-LINEAR LEAST-SQUARES ANALYSIS               *
*                                  *
*  Comment                             *
*  Comment                             *
*                                  *
*  DATA INPUT FILE: outletin.in                *
*                                  *
*****************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME     INITIAL VALUE  FITTING
V.......  .9144E+01     Y
D.......  .1830E+02     Y
R.......  .1000E+01     N
mu......  .0000E+00     N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =  1.0000 & DURATION =  1.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50

ITER  SSQ      V.....   D.....
 0  .7256E-02  .914E+01  .183E+02
 1  .1172E-02  .951E+01  .153E+02
 2  .1002E-02  .945E+01  .155E+02
 3  .9982E-03  .946E+01  .153E+02
 4  .9982E-03  .946E+01  .153E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
      V.....  D.....
 V.... 1.000
 D.... -.131  1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .99248755
 (COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) =  .2321E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                    95% CONFIDENCE LIMITS
NAME   VALUE    S.E.COEFF. T-VALUE   LOWER    UPPER
V.... .9456E+01  .1960E-01 .4824E+03 .9416E+01  .9495E+01
D.... .1534E+02  .3741E+00 .4102E+02 .1459E+02  .1610E+02

------------------ORDERED BY COMPUTER INPUT------------------
```

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESIDUAL
1	192.2	0.0417	0.0018	0	0.0018
2	192.2	0.9583	0.0019	0	0.0019
3	192.2	1.8889	0.002	0	0.002
4	192.2	2.7292	0.002	0	0.002
5	192.2	3.7431	0.0018	0	0.0018
6	192.2	4.7153	0.0016	0	0.0016
7	192.2	5.875	0.0011	0	0.0011
8	192.2	6.7604	0.0011	0	0.0011
9	192.2	7.7222	0.0011	0	0.0011
10	192.2	8.8889	0.0015	0	0.0015
11	192.2	9.6944	0.0015	0	0.0015
12	192.2	10.7396	0.0016	0	0.0016
13	192.2	11.8785	0.0016	0	0.0016
14	192.2	12.8472	0.0028	0.0002	0.0026
15	192.2	13.75	0.0053	0.0013	0.004
16	192.2	14.9479	0.0157	0.0082	0.0075
17	192.2	15.7535	0.0301	0.0205	0.0096
18	192.2	16.2396	0.0416	0.0322	0.0093
19	192.2	16.6979	0.0559	0.0464	0.0095
20	192.2	17.2229	0.0713	0.0656	0.0056
21	192.2	17.691	0.0901	0.0845	0.0056
22	192.2	18.7292	0.1194	0.1245	-0.0051
23	192.2	19.2076	0.1317	0.1387	-0.007
24	192.2	19.8125	0.1456	0.15	-0.0043
25	192.2	20.2028	0.1553	0.1528	0.0025
26	192.2	20.5729	0.1553	0.1523	0.0031
27	192.2	21.0146	0.1571	0.1478	0.0093
28	192.2	21.7257	0.1445	0.1334	0.0111
29	192.2	22.1417	0.1262	0.1221	0.0042
30	192.2	22.5458	0.1155	0.1098	0.0057
31	192.2	23.0188	0.0984	0.0949	0.0035
32	192.2	23.525	0.0823	0.0792	0.0031
33	192.2	24.0417	0.0682	0.0642	0.004
34	192.2	24.6806	0.048	0.0479	0.0001
35	192.2	25.1917	0.041	0.0369	0.004
36	192.2	25.7153	0.021	0.0278	-0.0068
37	192.2	26.1736	0.0149	0.0213	-0.0063
38	192.2	26.7458	0.0106	0.0149	-0.0043
39	192.2	27.7431	0.0064	0.0077	-0.0012
40	192.2	28.7222	0.0044	0.0038	0.0007
41	192.2	29.7292	0.0033	0.0017	0.0015
42	192.2	30.8854	0.0032	0.0007	0.0025
43	192.2	31.6771	0.0025	0.0003	0.0021
44	192.2	32.6979	0.0025	0.0001	0.0024
45	192.2	33.5083	0.0022	0.0001	0.0022

Table C-5. Test 3 Outlet CXTFIT Data. E) Column 5 (2 pages) (Continued)

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: outletin in                                *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
FLUX-AVERAGED CONCENTRATION
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.9144E+01	Y
D........	.1830E+02	Y
R........	1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 1.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.1610E-01	.914E+01	.183E+02
1	.9299E-02	.944E+01	.757E+01
2	2311E-02	.938E+01	.103E+02
3	.2115E-02	.936E+01	.108E+02
4	.2114E-02	.935E+01	.108E+02
5	.2114E-02	.935E+01	.108E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.068	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .98823836
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .4916E-04

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	.9354E+01	2154E-01	.4343E+03	.9310E+01	.9397E+01
D....	1077E+02	.3600E+00	.2990E+02	1004E+02	.1149E+02

-------------------ORDERED BY COMPUTER INPUT-------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	CONCENTRATION FITTED	RESIDUAL
1	194.2	0.0417	0.0022	0	0.0022
2	194.2	0.9549	0.0021	0	0.0021
3	194.2	1.8819	0.0021	0	0.0021
4	194.2	2.7257	0.002	0	0.002
5	194.2	3.7361	0.0017	0	0.0017
6	194.2	4.7083	0.0017	0	0.0017
7	194.2	5.8715	0.0012	0	0.0012
8	194.2	6.7535	0.0013	0	0.0013
9	194.2	7.7153	0.0013	0	0.0013
10	194.2	8.8819	0.0016	0	0.0016
11	194.2	9.6875	0.0016	0	0.0016
12	194.2	10.7326	0.0017	0	0.0017
13	194.2	11.875	0.0016	0	0.0016
14	194.2	12.8403	0.0026	0	0.0026
15	194.2	13.7431	0.002	0.0001	0.0019
16	194.2	14.941	0.0031	0.0013	0.0018
17	194.2	15.7465	0.0055	0.0053	0.0002
18	194.2	16.2347	0.0136	0.0109	0.0027
19	194.2	16.691	0.0233	0.0195	0.0039
20	194.2	17.2174	0.0414	0.0344	0.0071
21	194.2	17.6875	0.067	0.0525	0.0145
22	194.2	18.7222	0.1129	0.1045	0.0084
23	194.2	19.2021	0.1439	0.1296	0.0143
24	194.2	19.8056	0.16	0.1563	0.0037
25	194.2	20.2	0.1795	0.1686	0.0109
26	194.2	20.566	0.1815	0.1753	0.0062
27	194.2	21.009	0.1903	0.1772	0.0132
28	194.2	21.7222	0.169	0.1663	0.0027
29	194.2	22.1375	0.1559	0.1536	0.0023
30	194.2	22.5417	0.1406	0.1383	0.0023
31	194.2	23.0153	0.1235	0.1184	0.0052
32	194.2	23.5243	0.1129	0.0964	0.0164
33	194.2	24.0347	0.0821	0.0757	0.0064
34	194.2	24.6736	0.062	0.0533	0.0086
35	194.2	25.1882	0.0509	0.0388	0.0121
36	194.2	25.7118	0.0427	0.0272	0.0155
37	194.2	26.1701	0.0322	0.0195	0.0127
38	194.2	26.7403	0.0221	0.0125	0.0097
39	194.2	27.7361	0.0111	0.0053	0.0058
40	194.2	28.7153	0.0065	0.0021	0.0043
41	194.2	29.7222	0.0041	0.0008	0.0034
42	194.2	30.8771	0.0029	0.0002	0.0027
43	194.2	31.6701	0.0026	0.0001	0.0025
44	194.2	32.691	0.0024	0	0.0024
45	194.2	33.5069	0.0023	0	0.0022

Table C-5. Test 3 Outlet CXTFIT Data. F) Column 6 (2 pages) (Continued)

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: outletin.in                                *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
FLUX-AVERAGED CONCENTRATION
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V........	.9144E+01	Y
D........	.1830E+02	Y
R........	.1000E+01	N
mu.......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 1.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.7424E-01	.914E+01	.183E+02
1	.2039E-01	.968E+01	.383E+02
2	.1288E-01	.103E+02	.484E+02
3	.1262E-01	.104E+02	.452E+02
4	.1258E-01	.104E+02	.438E+02
5	.1258E-01	.104E+02	.433E+02
6	.1258E-01	.104E+02	.431E+02
7	.1258E-01	.104E+02	.430E+02
8	.1258E-01	.104E+02	.430E+02
9	.1258E-01	.104E+02	.430E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.081	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .77356904
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .2925E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

NAME	VALUE	S.E.COEFF	T-VALUE	95% CONFIDENCE LIMITS LOWER	UPPER
V..	.1042E+02	.1531E+00	.6804E+02	.1011E+02	.1072E+02
D...	.4295E+02	.4941E+01	.8692E+01	.3298E+02	.5292E+02

-------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	192 8	0.04	0.0016	0	0.0016
2	192.8	0.96	0.0019	0	0.0019
3	192.8	1.89	0 0019	0	0.0019
4	192.8	2.73	0 0019	0	0.0019
5	192.8	3 74	0.0017	0	0.0017
6	192 8	4.71	0.0016	0	0.0016
7	192.8	5.88	0.0013	0	0.0013
8	192.8	6.76	0.0013	0	0.0013
9	192.8	7.72	0.0013	0	0.0013
10	192.8	8.89	0.0014	0.0002	0 0012
11	192 8	9.69	0.0014	0.0008	0.0006
12	192.8	10.74	0.0015	0.0039	-0.0024
13	192 8	11.88	0.0015	0.0132	-0.0117
14	192 8	12 85	0.004	0.0277	-0.0237
15	192.8	13.75	0.0105	0.0461	-0.0356
16	192.8	14.94	0.033	0 0731	-0.0402
17	192.8	15.75	0.0564	0.0895	-0 033
18	192.8	16.24	0.0708	0 0973	-0.0266
19	192.8	16.69	0.0845	0.1029	-0.0184
20	192.8	17.22	0.0927	0.1072	-0.0144
21	192.8	17.69	0.1045	0.1089	-0.0044
22	192 8	18.73	0.1017	0.1061	-0.0044
23	192 8	19 2	0.1037	0.1023	0.0015
24	192.8	19.81	0.0886	0.0956	-0 007
25	192.8	20.2	0.0786	0.0906	-0.012
26	192 8	20 57	0 0762	0.0854	-0.0093
27	192.8	21 01	0.0661	0 079	-0.0129
28	192.8	21 73	0 0462	0 0681	-0.0219
29	192.8	22.14	0 0371	0 062	-0.0249
30	192 8	22 54	0 0287	0.0562	-0.0275
31	192.8	23.02	0 0203	0.0496	-0.0293
32	192.8	23 52	0.0135	0.0431	-0 0296
33	192.8	24.04	0.01	0.037	-0.027
34	192.8	24.68	0.0058	0.0302	-0 0245
35	192.8	25.19	0.0041	0.0256	-0 0215
36	192 8	25.72	0.0042	0.0213	-0.0171
37	192.8	26.17	0.0031	0.0182	-0.015
38	192.8	26.74	0.0026	0.0147	-0.0122
39	192.8	27.74	0 0025	0.01	-0.0075
40	192.8	28.72	0.002	0.0068	-0.0047
41	192 8	29 73	0 0018	0.0044	-0.0026
42	192.8	30.88	0.0019	0.0027	-0.0008
43	192.8	31 68	0 0018	0.0019	-0.0001
44	192.8	32 69	0.0019	0.0012	0.0008
45	192.8	33 51	0.0018	0.0008	0.001

Table C-5. Test 3 Outlet CXTFIT Data. G) Column 7 (2 pages) (Continued)

```
*****************************************************************
*                                         *
*   CXTFIT VE
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE          *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                *
*                                         *
*   Comment                                   *
*   Comment                                   *
*                                         *
*   DATA INPUT FILE:  outletin.in                     *
*                                         *
*****************************************************************


MODEL DESCRIPTION
=================
 DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
 FLUX-AVERAGED CONCENTRATION
 REAL TIME (t), POSITION(x)
  (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)


INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE  FITTING
V.......   .9144E+01     Y
D.......   .1830E+02     Y
R.......   .1000E+01     N
mu......   .0000E+00     N


BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
 SINGLE PULSE OF CONC. =  1.0000 & DURATION =  1.0000
 SOLUTE FREE INITIAL CONDITION
 NO PRODUCTION TERM


PARAMETER ESTIMATION MODE
=========================
 MAXIMUM NUMBER OF ITERATIONS =  50


ITER   SSQ        V....    D....
0   .8888E-01  .914E+01  .183E+02
1   .1951E-01  .103E+02  .295E+02
2   .5440E-02  .104E+02  .179E+02
3   .4666E-02  .104E+02  .147E+02
4   .4582E-02  .104E+02  .155E+02
5   .4581E-02  .104E+02  .154E+02
6   .4581E-02  .104E+02  .154E+02
7   .4581E-02  .104E+02  .154E+02


COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
       V....  D....
 V....  1.000
 D....  -.125  1.000

 RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .97358998
  (COEFFICIENT OF DETERMINATION)

 MEAN SQUARE FOR ERROR (MSE) =  .1065E-03


NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                                  95% CONFIDENCE LIMITS
NAME    VALUE     S.E.COEFF.  T-VALUE    LOWER      UPPER
V....  .1043E+02  .3965E-01  .2631E+03  .1035E+02  .1051E+02
D....  .1542E+02  .8600E+00  .1792E+02  .1368E+02  .1715E+02
```

------------------ORDERED BY COMPUTER INPUT------------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	191.2	0.0417	0.0019	0	0.0019
2	191.2	0.9549	0.0023	0	0.0023
3	191.2	1.8819	0.0021	0	0.0021
4	191.2	2.7257	0.002	0	0.002
5	191.2	3.7361	0.0019	0	0.0019
6	191.2	4.7083	0.0017	0	0.0017
7	191.2	5.8715	0.0015	0	0.0015
8	191.2	6.7569	0.0015	0	0.0015
9	191.2	7.7153	0.0014	0	0.0014
10	191.2	8.8819	0.0015	0	0.0015
11	191.2	9.6875	0.0015	0	0.0015
12	191.2	10.7326	0.0016	0	0.0016
13	191.2	11.875	0.0016	0.0003	0.0013
14	191.2	12.8438	0.0048	0.0022	0.0026
15	191.2	13.7188	0.0152	0.0094	0.0058
16	191.2	14.941	0.057	0.0403	0.0167
17	191.2	15.7465	0.1	0.0772	0.0228
18	191.2	16.2389	0.13	0.1035	0.0265
19	191.2	16.691	0.14	0.1274	0.0126
20	191.2	17.2181	0.16	0.1516	0.0084
21	191.2	17.6875	0.18	0.1672	0.0128
22	191.2	18.7222	0.18	0.175	0.005
23	191.2	19.2021	0.17	0.1666	0.0034
24	191.2	19.8056	0.18	0.1479	0.0321
25	191.2	20.1965	0.14	0.1327	0.0073
26	191.2	20.566	0.13	0.1172	0.0128
27	191.2	21.0118	0.11	0.0984	0.0116
28	191.2	21.7222	0.09	0.0705	0.0195
29	191.2	22.1389	0.07	0.0564	0.0136
30	191.2	22.5417	0.06	0.0446	0.0154
31	191.2	23.0167	0.04	0.033	0.007
32	191.2	23.5243	0.03	0.0234	0.0066
33	191.2	24.0347	0.02	0.0161	0.0039
34	191.2	24.6736	0.02	0.0098	0.0102
35	191.2	25.1889	0.01	0.0064	0.0036
36	191.2	25.7118	0.01	0.0041	0.0059
37	191.2	26.1715	0.01	0.0027	0.0073
38	191.2	26.7403	0.01	0.0016	0.0084
39	191.2	27.7396	0	0.0006	-0.0006
40	191.2	28.7153	0	0.0002	-0.0002
41	191.2	29.7222	0	0.0001	-0.0001
42	191.2	30.8785	0	0	0
43	191.2	31.6736	0	0	0
44	191.2	32.691	0	0	0
45	191.2	33.5069	0.0021	0	0.0021

Table C-5. Test 3 Outlet CXTFIT Data. H) Column 8 (2 pages) (Continued)

```
*****************************************************************
*                                                               *
*   CXTFIT VERSION 2.1 (4/17/99)                                *
*   ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                *
*   NON-LINEAR LEAST-SQUARES ANALYSIS                           *
*                                                               *
*   Comment                                                     *
*   Comment                                                     *
*                                                               *
*   DATA INPUT FILE: outletin in                                *
*                                                               *
*****************************************************************
```

MODEL DESCRIPTION

DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
FLUX-AVERAGED CONCENTRATION
REAL TIME (t), POSITION(x)
(D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS

NAME	INITIAL VALUE	FITTING
V......	9144E+01	Y
D......	1830E+02	Y
R......	.1000E+01	N
mu......	.0000E+00	N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS

SINGLE PULSE OF CONC. = 1.0000 & DURATION = 1.0000
SOLUTE FREE INITIAL CONDITION
NO PRODUCTION TERM

PARAMETER ESTIMATION MODE

MAXIMUM NUMBER OF ITERATIONS = 50

ITER	SSQ	V....	D....
0	.2950E-01	.914E+01	.183E+02
1	.2086E-01	.965E+01	.927E+01
2	1435E-01	.951E+01	.122E+02
3	.1430E-01	.948E+01	.121E+02
4	.1430E-01	.948E+01	.121E+02
5	.1430E-01	.948E+01	.121E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS

	V....	D....
V....	1.000	
D....	-.119	1.000

RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .92896288
(COEFFICIENT OF DETERMINATION)

MEAN SQUARE FOR ERROR (MSE) = .3325E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS

				95% CONFIDENCE LIMITS	
NAME	VALUE	S.E.COEFF.	T-VALUE	LOWER	UPPER
V....	9484E+01	.6203E-01	.1529E+03	.9358E+01	.9609E+01
D....	.1206E+02	.1039E+01	1160E+02	.9962E+01	.1416E+02

-----------------ORDERED BY COMPUTER INPUT-----------------

NO	DISTANCE	TIME	CONCENTRATION OBS	CONCENTRATION FITTED	RESIDUAL
1	190.4	0.0417	0.0024	0	0.0024
2	190.4	0.9583	0.0022	0	0.0022
3	190.4	1.8889	0.0022	0	0.0022
4	190.4	2.7292	0.0022	0	0.0022
5	190.4	3.7431	0.0021	0	0.0021
6	190.4	4.7118	0.0021	0	0.0021
7	190.4	5.875	0.0019	0	0.0019
8	190.4	6.7604	0.0018	0	0.0018
9	190.4	7.7222	0.0019	0	0.0019
10	190.4	8.8854	0.0019	0	0.0019
11	190.4	9.691	0.0019	0	0.0019
12	190.4	10.7361	0.002	0	0.002
13	190.4	11.8785	0.0018	0	0.0018
14	190.4	12.8472	0.0031	0.0001	0.003
15	190.4	13.75	0.0038	0.0005	0.0032
16	190.4	14.9444	0.0166	0.0051	0.0115
17	190.4	15.7535	0.039	0.0159	0.0232
18	190.4	16.241	0.0558	0.0276	0.0282
19	190.4	16.6979	0.0752	0.0428	0.0324
20	190.4	17.2243	0.1012	0.0652	0.036
21	190.4	17.6875	0.1267	0.088	0.0387
22	190.4	18.7257	0.1598	0.1392	0.0206
23	190.4	19.2021	0.1728	0.1572	0.0156
24	190.4	19.8056	0.1953	0.1707	0.0245
25	190.4	20.1958	0.1891	0.1731	0.016
26	190.4	20.566	0.1853	0.1708	0.0145
27	190.4	21.0111	0.1953	0.1627	0.0326
28	190.4	21.7222	0.1593	0.1405	0.0188
29	190.4	22.141	0.153	0.1242	0.0287
30	190.4	22.5431	0.1326	0.1078	0.0248
31	190.4	23.016	0.1113	0.0887	0.0226
32	190.4	23.5243	0.0896	0.0697	0.0199
33	190.4	24.0347	0.0773	0.053	0.0243
34	190.4	24.6736	0.0641	0.0361	0.028
35	190.4	25.1896	0.0532	0.0257	0.0275
36	190.4	25.7118	0.0416	0.0177	0.0239
37	190.4	26.1736	0.0319	0.0125	0.0194
38	190.4	26.7118	0.0222	0.0081	0.0141
39	190.4	27.75	0.0108	0.0033	0.0074
40	190.4	28.7188	0.0069	0.0013	0.0055
41	190.4	29.7326	0.0047	0.0005	0.0042
42	190.4	30.8819	0.0032	0.0001	0.0031
43	190.4	31.6771	0.0029	0.0001	0.0028
44	190.4	32.6944	0.0028	0	0.0027
45	190.4	33.5104	0.0026	0	0.0025

Table C-5. Test 3 Outlet CXTFIT Data. I) Column 9 (2 pages) (Continued)

```
*****************************************************************
*                                                               *
*  CXTFIT VERSION 2.1 (4/17/99)                                 *
*  ANALYTICAL SOLUTIONS FOR ONE-DIMENSIONAL CDE                 *
*  NON-LINEAR LEAST-SQUARES ANALYSIS                            *
*                                                               *
*  Comment                                                      *
*  Comment                                                      *
*                                                               *
*  DATA INPUT FILE: outletin.in                                 *
*                                                               *
*****************************************************************

MODEL DESCRIPTION
=================
  DETERMINISTIC EQUILIBRIUM CDE (MODE=1)
  FLUX-AVERAGED CONCENTRATION
  REAL TIME (t), POSITION(x)
   (D,V,mu, AND gamma ARE ALSO DIMENSIONAL)

INITIAL VALUES OF COEFFICIENTS
==============================
NAME      INITIAL VALUE   FITTING
V.......   .9144E+01        Y
D.......   .1830E+02        Y
R.......   .1000E+01        N
mu......   .0000E+00        N

BOUNDARY, INITIAL, AND PRODUCTION CONDITIONS
============================================
  SINGLE PULSE OF CONC. =  1.0000 & DURATION =  1.0000
  SOLUTE FREE INITIAL CONDITION
  NO PRODUCTION TERM

PARAMETER ESTIMATION MODE
=========================
  MAXIMUM NUMBER OF ITERATIONS =  50

ITER   SSQ        V.....    D.....
0   .1094E-01  .914E+01  .183E+02
1   .9706E-02  .925E+01  .144E+02
2   .9403E-02  .921E+01  .156E+02
3   .9392E-02  .922E+01  .153E+02
4   .9392E-02  .921E+01  .154E+02
5   .9391E-02  .921E+01  .154E+02
6   .9391E-02  .921E+01  .154E+02

COVARIANCE MATRIX FOR FITTED PARAMETERS
=======================================
        V....   D....
  V....  1.000
  D....  -.133  1.000

  RSQUARE FOR REGRESSION OF OBSERVED VS PREDICTED = .93882183
   (COEFFICIENT OF DETERMINATION)

  MEAN SQUARE FOR ERROR (MSE) =  .2184E-03

NON-LINEAR LEAST SQUARES ANALYSIS, FINAL RESULTS
================================================

                         95% CONFIDENCE LIMITS
NAME    VALUE    S.E.COEFF.  T-VALUE    LOWER      UPPER
V....  .9213E+01  .6099E-01  .1511E+03  .9090E+01  .9336E+01
D....  .1538E+02  .1168E+01  .1316E+02  .1302E+02  .1773E+02
```

-----------------ORDERED BY COMPUTER INPUT-----------------

NO	DISTANCE	TIME	CONCENTRATION OBS	FITTED	RESI-DUAL
1	187 9	0 0417	0 0019	0	0.0019
2	187.9	0 9583	0.0019	0	0.0019
3	187.9	1 8889	0.0019	0	0.0019
4	187.9	2.7292	0.0019	0	0.0019
5	187.9	3.7431	0.0018	0	0 0018
6	187.9	4.7118	0.0016	0	0.0016
7	187.9	5.8715	0.0016	0	0.0016
8	187.9	6.7569	0.0016	0	0.0016
9	187.9	7.7188	0.0016	0	0 0016
10	187.9	8 8854	0.0016	0	0.0016
11	187.9	9.691	0.0016	0	0.0016
12	187.9	10.7361	0.0017	0	0.0017
13	187.9	11 8785	0 0018	0	0.0018
14	187.9	12.8472	0.0038	0.0003	0.0036
15	187 9	13.75	0.0109	0.0015	0.0093
16	187.9	14.941	0.0297	0.0087	0.021
17	187 9	15.7535	0.0495	0.0213	0.0282
18	187.9	16.2382	0.0633	0.0329	0.0304
19	187.9	16.6944	0.0735	0.0466	0.0269
20	187.9	17.2222	0.0921	0.0652	0.0268
21	187.9	17.691	0.1134	0.0832	0.0302
22	187.9	18.7292	0.1291	0.1212	0.0079
23	187.9	19.2042	0.1371	0 1346	0.0025
24	187.9	19 8125	0 1546	0.1456	0 009
25	187.9	20.2021	0 1572	0.1486	0.0087
26	187.9	20.5729	0 1542	0.1484	0.0058
27	187.9	21 0132	0.1719	0.1446	0 0273
28	187.9	21.7257	0.1511	0.1317	0.0194
29	187.9	22.1424	0 1413	0.1213	0 0201
30	187.9	22.5437	0 1334	0 11	0.0234
31	187.9	23.0201	0.1206	0 0959	0.0247
32	187.9	23.5243	0.1022	0.081	0.0213
33	187.9	24.0417	0.0892	0.0664	0.0228
34	187 9	24.6806	0.0686	0.0504	0.0182
35	187.9	25.1917	0.0538	0.0395	0.0142
36	187.9	25.7153	0.043	0.0302	0.0128
37	187.9	26.1729	0.0316	0 0235	0.0081
38	187.9	26.7458	0.0226	0 0168	0 0058
39	187.9	27.7431	0.0114	0.009	0.0024
40	187.9	28.7222	0.0063	0.0046	0.0017
41	187.9	29.7264	0.0039	0.0022	0.0017
42	187 9	30.8854	0.0027	0.0009	0.0019
43	187.9	31.6771	0.0023	0.0005	0.0019
44	187.9	32.6944	0.0024	0.0002	0.0022
45	187.9	33.5076	0.0022	0.0001	0.0021

Appendix D. TCE Reductive Dechlorination Modeling Data

Table D-1. Microcosm Data for Linear Regression. A) Treatment X

Biotic

(mg/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	LN for linear regression TCE	cis-DCE	VC
0	6.15	0.00	0.00	0.00	1.81596329	#NUM!	#NUM!
7	5.08	0.00	0.00	0.00	1.625208894	#NUM!	#NUM!
15	4.93	0.00	0.00	0.00	1.596203388	#NUM!	#NUM!
23	5.52	0.00	0.00	0.00	1.708095816	#NUM!	#NUM!
28	5.28	0.00	0.00	0.00	1.663324275	#NUM!	#NUM!
35	4.73	0.00	0.00	0.00	1.553151824	#NUM!	#NUM!
41	5.05	0.00	0.00	0.00	1.62024794	#NUM!	#NUM!
54	3.44	0.00	0.00	0.00	1.236139853	#NUM!	#NUM!
77	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

(mmol/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	TCE	cis-DCE	VC
0	0.047	0.000	0.000	0.000	-3.060759586	#NUM!	#NUM!
7	0.039	0.000	0.000	0.000	-3.251513982	#NUM!	#NUM!
15	0.038	0.000	0.000	0.000	-3.280519489	#NUM!	#NUM!
23	0.042	0.000	0.000	0.000	-3.168627061	#NUM!	#NUM!
28	0.040	0.000	0.000	0.000	-3.213398601	#NUM!	#NUM!
35	0.036	0.000	0.000	0.000	-3.323571053	#NUM!	#NUM!
41	0.039	0.000	0.000	0.000	-3.256474937	#NUM!	#NUM!
54	0.026	0.000	0.000	0.000	-3.640583024	#NUM!	#NUM!

Abiotic

(mg/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	TCE	cis-DCE	VC
0	5.56	0.00	0.00	0.00	1.716018284	#NUM!	#NUM!
7	5.11	0.00	0.00	0.00	1.631545072	#NUM!	#NUM!
15	5.01	0.00	0.00	0.00	1.611629509	#NUM!	#NUM!
23	5.36	0.00	0.00	0.00	1.679746008	#NUM!	#NUM!
28	4.93	0.00	0.00	0.00	1.596194606	#NUM!	#NUM!
35	4.45	0.00	0.00	0.00	1.491854857	#NUM!	#NUM!
41	4.76	0.00	0.00	0.00	1.560097797	#NUM!	#NUM!
54	3.29	0.00	0.00	0.00	1.190081769	#NUM!	#NUM!
77					#NUM!	#NUM!	#NUM!

(mmol/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	TCE	cis-DCE	VC
0	0.042	0.000	0.000	0.000	-3.160704593	#NUM!	#NUM!
7	0.039	0.000	0.000	0.000	-3.245177805	#NUM!	#NUM!
15	0.038	0.000	0.000	0.000	-3.265093367	#NUM!	#NUM!
23	0.041	0.000	0.000	0.000	-3.196976869	#NUM!	#NUM!
28	0.038	0.000	0.000	0.000	-3.280528271	#NUM!	#NUM!
35	0.034	0.000	0.000	0.000	-3.38486802	#NUM!	#NUM!
41	0.036	0.000	0.000	0.000	-3.316625079	#NUM!	#NUM!
54	0.025	0.000	0.000	0.000	-3.686641107	#NUM!	#NUM!

(Table continued on next page)

Table D-1. Microcosm Data for Linear Regression. B) Treatment H (2 pages) (Continued)

Biotic

(mg/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	LN TCE	LN cis-DCE	LN VC
0	4.96	0.00	0.00	0.09	1.601	#NUM!	-2.464
7	4.28	0.09	0.00	0.08	1.454	-2.453	-2.525
11	3.77	0.13	0.00	0.08	1.326	-2.024	-2.556
14	3.76	0.28	0.00	0.12	1.324	-1.261	-2.122
18	3.70	0.60	0.00	0.35	1.307	-0.507	-1.048
21	3.33	0.74	0.00	0.72	1.203	-0.303	-0.333
23	2.50	0.66	0.01	1.17	0.917	-0.415	0.153
28	1.01	0.33	0.01	2.96	0.006	-1.104	1.086
36	0.01	0.00	0.04	3.87	-4.716	#NUM!	1.352
41	0.00	0.00	0.03	3.40	#NUM!	#NUM!	1.222
53	0.00	0.00	0.03	0.01	#NUM!	#NUM!	-4.605
67	0.00	0.00	0.03	0.00	-6.548	#NUM!	#NUM!
76	0.00	0.00	0.04	0.00	#NUM!	#NUM!	#NUM!

(mmol/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	LN TCE	LN cis-DCE	LN VC
0	0.038	0.000	0.000	0.001	-3.276	#NUM!	-6.598
7	0.033	0.001	0.000	0.001	-3.423	-7.026	-6.659
11	0.029	0.001	0.000	0.001	-3.551	-6.597	-6.689
14	0.029	0.003	0.000	0.002	-3.553	-5.834	-6.255
18	0.028	0.006	0.000	0.006	-3.569	-5.080	-5.182
21	0.025	0.008	0.000	0.011	-3.674	-4.875	-4.467
23	0.019	0.007	0.000	0.019	-3.960	-4.988	-3.981
28	0.008	0.003	0.000	0.047	-4.871	-5.676	-3.047
36	0.000	0.000	0.000	0.062	-9.593	#NUM!	-2.781
41	0.000	0.000	0.000	0.054	#NUM!	#NUM!	-2.911
53	0.000	0.000	0.000	0.000	#NUM!	#NUM!	-8.739
67	0.000	0.000	0.000	0.000	-11.424	#NUM!	#NUM!
76	0.000	0.000	0.000	0.000	#NUM!	#NUM!	#NUM!

Abiotic

(mg/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	LN TCE	LN cis-DCE	LN VC
0	5.39	0.14	0.00	0.04	1.685	-1.995	-3.236
8	4.92	0.14	0.00	0.04	1.594	-1.980	-3.300
12	4.72	0.10	0.00	0.03	1.552	-2.288	-3.437
16	4.77	0.09	0.00	0.02	1.563	-2.416	-3.958
18	5.52	0.11	0.00	0.02	1.708	-2.222	-3.819
22	5.71	0.12	0.00	0.04	1.742	-2.095	-3.251
24	5.45	0.12	0.00	0.04	1.696	-2.093	-3.314
29	5.44	0.08	0.00	0.02	1.694	-2.515	-3.924
37	4.43	0.09	0.00	0.01	1.489	-2.429	-4.359
42	5.06	0.08	0.00	0.01	1.622	-2.489	-4.381
54	3.30	0.12	0.00	0.03	1.195	-2.153	-3.561
68	4.86	0.11	0.00	0.03	1.581	-2.165	-3.668
77	4.65	0.11	0.00	0.02	1.536	-2.195	-3.813

(mmol/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	LN TCE	LN cis-DCE	LN VC
0	0.041	0.001	0.000	0.001	-3.192	-6.567	-7.370
8	0.038	0.001	0.000	0.001	-3.282	-6.552	-7.433
12	0.036	0.001	0.000	0.001	-3.325	-6.861	-7.571
16	0.036	0.001	0.000	0.000	-3.314	-6.988	-8.091

18	0.042	0.001	0.000	0.000	-3.168	-6.794	-7.952
22	0.044	0.001	0.000	0.001	-3.134	-6.668	-7.385
24	0.042	0.001	0.000	0.001	-3.180	-6.665	-7.447
29	0.041	0.001	0.000	0.000	-3.183	-7.087	-8.057
37	0.034	0.001	0.000	0.000	-3.387	-7.002	-8.493
42	0.039	0.001	0.000	0.000	-3.255	-7.062	-8.515
54	0.025	0.001	0.000	0.000	-3.682	-6.726	-7.695
68	0.037	0.001	0.000	0.000	-3.296	-6.738	-7.801
77	0.035	0.001	0.000	0.000	-3.341	-6.768	-7.946

Table D-1. Microcosm Data for Linear Regression. C) Treatment I (2 pages) (Continued)

Biotic	(mg/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	TCE	cis-DCE	VC
	0	5.78	0.00	0.00	0.00	1.76	#NUM!	#NUM!
	8	4.89	0.00	0.00	0.00	1.59	#NUM!	#NUM!
	14	4.72	0.00	0.00	0.00	1.55	#NUM!	#NUM!
	16	4.78	0.02	0.00	0.00	1.56	-3.69	#NUM!
	22	3.59	0.51	0.00	0.00	1.28	-0.67	#NUM!
	26	0.85	2.95	0.00	0.00	-0.17	1.08	#NUM!
	29	0.05	3.33	0.00	0.01	-3.00	1.20	-4.74
	34	0.01	2.98	0.00	0.05	-4.61	1.09	-3.05
	38	0.00	2.45	0.00	0.13	#NUM!	0.90	-2.05
	41	0.00	1.61	0.00	0.93	#NUM!	0.48	-0.07
	54	0.00	0.60	0.00	1.06	#NUM!	-0.51	0.06
	69	0.00	0.00	0.00	2.07	#NUM!	#NUM!	0.73
	79	0.00	0.00	0.00	0.57	#NUM!	#NUM!	-0.57

(mmol/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	TCE	cis-DCE	VC
0	0.044	0.000	0.000	0.000	-3.122	#NUM!	#NUM!
8	0.037	0.000	0.000	0.000	-3.289	#NUM!	#NUM!
14	0.036	0.000	0.000	0.000	-3.325	#NUM!	#NUM!
16	0.036	0.000	0.000	0.000	-3.312	-8.264	#NUM!
22	0.027	0.005	0.000	0.000	-3.600	-5.238	#NUM!
26	0.006	0.031	0.000	0.000	-5.045	-3.489	#NUM!
29	0.000	0.034	0.000	0.000	-7.872	-3.371	-8.878
34	0.000	0.031	0.000	0.001	-9.482	-3.481	-7.179
38	0.000	0.025	0.000	0.002	#NUM!	-3.676	-6.188
41	0.000	0.017	0.000	0.015	#NUM!	-4.097	-4.203
54	0.000	0.006	0.000	0.017	#NUM!	-5.083	-4.078
69	0.000	0.000	0.000	0.033	#NUM!	#NUM!	-3.406
79	0.000	0.000	0.000	0.009	#NUM!	#NUM!	-4.703

Abiotic	(mg/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	TCE	cis-DCE	VC
	0	5.63	0.02	0.00	0.00	1.73	-3.85	#NUM!
	8	4.79	0.00	0.00	0.00	1.57	#NUM!	#NUM!
	14	4.60	0.00	0.00	0.00	1.53	#NUM!	#NUM!
	16	4.51	0.00	0.00	0.00	1.51	#NUM!	#NUM!
	22	5.05	0.00	0.00	0.00	1.62	#NUM!	#NUM!
	26	4.87	0.00	0.00	0.00	1.58	#NUM!	#NUM!
	29	4.97	0.00	0.00	0.00	1.60	#NUM!	#NUM!
	34	4.55	0.00	0.00	0.00	1.52	#NUM!	#NUM!
	38	4.29	0.00	0.00	0.00	1.46	#NUM!	#NUM!
	41	4.63	0.00	0.00	0.00	1.53	#NUM!	#NUM!
	54	3.19	0.00	0.00	0.00	1.16	#NUM!	#NUM!
	69	4.37	0.00	0.00	0.00	1.48	#NUM!	#NUM!
	79	4.10	0.00	0.00	0.00	1.41	#NUM!	#NUM!

(mmol/L) Time (d)	Mean TCE	Mean cis-DCE	Mean trans-DCE	Mean VC	TCE	cis-DCE	VC
0	0.043	0.000	0.000	0.000	-3.149	-8.427	#NUM!
8	0.037	0.000	0.000	0.000	-3.310	#NUM!	#NUM!

14	0.035	0.000	0.000	0.000	-3.350	#NUM!	#NUM!
16	0.034	0.000	0.000	0.000	-3.371	#NUM!	#NUM!
22	0.038	0.000	0.000	0.000	-3.258	#NUM!	#NUM!
26	0.037	0.000	0.000	0.000	-3.293	#NUM!	#NUM!
29	0.038	0.000	0.000	0.000	-3.273	#NUM!	#NUM!
34	0.035	0.000	0.000	0.000	-3.361	#NUM!	#NUM!
38	0.033	0.000	0.000	0.000	-3.420	#NUM!	#NUM!
41	0.035	0.000	0.000	0.000	-3.344	#NUM!	#NUM!
54	0.024	0.000	0.000	0.000	-3.718	#NUM!	#NUM!
69	0.033	0.000	0.000	0.000	-3.401	#NUM!	#NUM!
79	0.031	0.000	0.000	0.000	-3.467	#NUM!	#NUM!

Table D-2. BIOCHLOR Concentration Data. A) Treatments A and X

TCE

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	7.0000	2.2615	1.6221	1.3307	1.1552	1.0347	0.9455	0.8760	0.8198	0.7732	0.7338
Biotic	7.0000	2.2615	1.6221	1.3307	1.1552	1.0347	0.9455	0.8760	0.8198	0.7732	0.7338

B) Treatment H

TCE

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	7.0000	2.2615	1.6221	1.3307	1.1552	1.0346	0.9450	0.8722	0.8082	0.7426	0.6648
Biotic	6.9999	0.0629	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

cis-DCE

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Biotic	0.0001	1.2025	0.6320	0.3661	0.2241	0.1415	0.0911	0.0595	0.0392	0.0260	0.0172

VC

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Biotic	0.0000	0.0721	0.0461	0.0275	0.0169	0.0107	0.0069	0.0045	0.0030	0.0020	0.0013

ETH

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Biotic	0.0000	0.0890	0.1426	0.1660	0.1745	0.1754	0.1726	0.1673	0.1601	0.1504	0.1366

C) Treatment I

TCE

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	7.0000	2.2615	1.6221	1.3307	1.1552	1.0347	0.9455	0.8760	0.8198	0.7732	0.7338
Biotic	6.9999	0.2462	0.0192	0.0017	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

cis-DCE

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Biotic	0.0000	0.8999	0.4100	0.1834	0.0844	0.0398	0.0192	0.0094	0.0046	0.0023	0.0011

VC

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Biotic	0.0000	0.1973	0.1602	0.0967	0.0527	0.0275	0.0141	0.0071	0.0036	0.0018	0.0009

ETH

Dist. from Source (ft)	0.00001	3	6	9	12	15	18	21	24	27	30
Abiotic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Biotic	0.0000	0.0813	0.1518	0.1876	0.1988	0.1974	0.1903	0.1814	0.1724	0.1639	0.1562